CHNOLOGY DEPT

Plastics

DEALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

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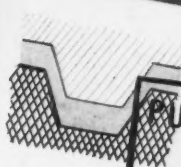
BX

these are the facts . . .

. . . about COBEX RIGID VINYL sheet

Light and strong—ideal for aircraft fittings.

Transparent as well as opaque. Clear or coloured.


Easily shaped in wooden moulds.

Resists corrosion (here shown as pipe lining).

Cobex is dimensionally stable and lies flat.

Cobex is easily joined by Hot Torch Welding.

Made in a wide colour range—glazed or matt.

Cobex is a good electrical insulator.

In ever wider use for deep draw moulding.

No fire risk—completely non-inflammable.

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CELLULOSE ACETATE

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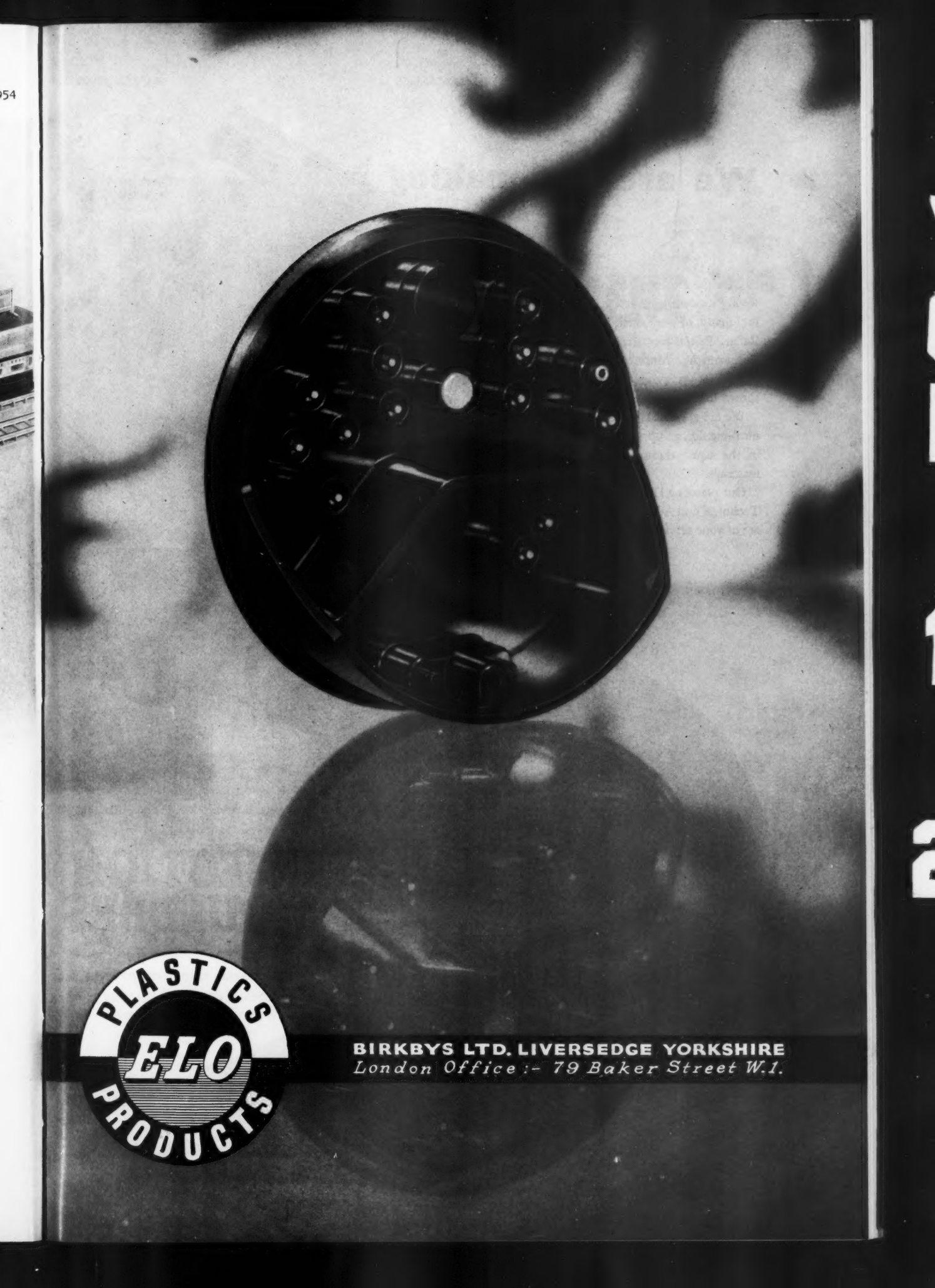
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PRODUCTS
BIRKBYS LTD. LIVERSEDGE YORKSHIRE
London Office :- 79 Baker Street W.1.

We are not making bullets . . .

. . . for the Defence Programme. But we are producing injection mouldings for many of the allied industries—Radar, Radio, Electrical, Automobile, Aeronautical, Marine, etc., etc. (some recent productions are shown here).

We are specialists in technical mouldings up to 16 ozs. in the usual thermo-plastic materials.

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REGISTERED TRADE MARK

DISTRENE

POLYSTYRENE
MOULDING MATERIALS

POLYSTYRENE

MAKES THIS DISK-RAK

STRONGER

Strength, dimensional stability and outstandingly good flow characteristics were pre-requisites of the moulding material for this 48-record storage rack.

DISTRENE 100 polystyrene moulding powder—selected to overcome weld and flow lines—met *all* the requirements for producing this intricate one-piece unit able to withstand day-to-day breakage hazards. Distrene 100 is polystyrene with exceptional strength at no extra cost—and meets B.S.1493. It is suitable for injection machines of all types and capacities. Please write for Leaflet A.

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The Disk-Rak, moulded in Distrene 100, is made by Thames Valley Moulders Ltd. and marketed by Selcol Products Ltd.

Reprocessed Polystyrene and Cellulose Acetate in metallic or opaque colours

Now you can have reprocessed polystyrene and cellulose acetate in those attractive metallic colours which hitherto have been obtainable only in virgin material.

Grist reprocessed compound, although costing far less than the virgin material, is guaranteed to have good moulding properties, and is suitable for innumerable products for which the use of top-grade material would be an unnecessary and wasteful expense. Now that the limitations on colour have been removed, you will no doubt find even more uses for Grist reprocessed polystyrene and cellulose acetate.

Samples for testing available on request.

Have you tried Grist Reprocessed Polythene supplied in all shades?

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ONE OF THE DOHM GROUP OF COMPANIES

We welcome enquiries for reprocessing customers own material into any colour including Metallics.

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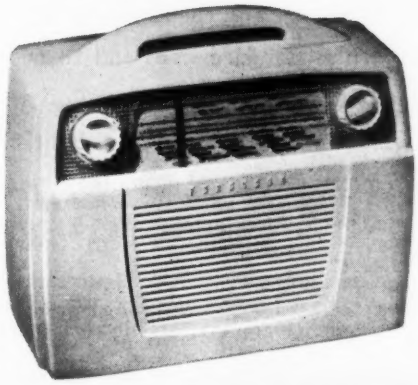
REGENTONE "MULTI 99" RADIOGRAM

ESCUTCHEON AND GRAM FRONT
in Cream Polystyrene

★ ★ ★ ★



FERGUSON "351" RADIO

HANDLE and KNOBS in Cream and Pastel Shades of Polystyrene.
SCALE in Amber and Crystal Clear Polystyrene.
WAVEBAND blocked in two or three colours.

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WAVEBAND WINDOW in Crystal Clear Polystyrene.
KNOBS — HANDLE — LOUVRE
in Cream Polystyrene.

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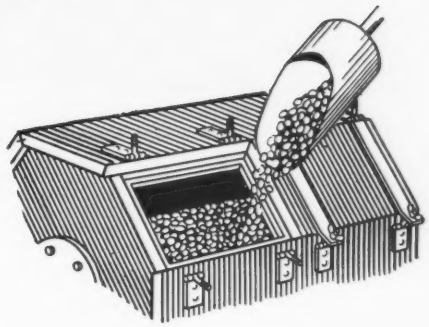
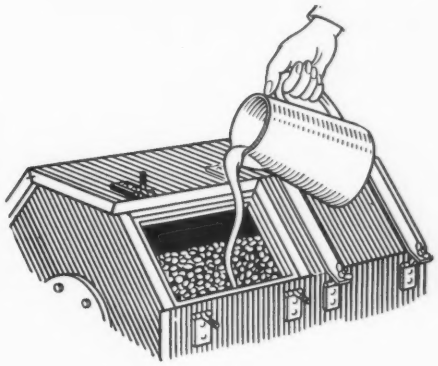
These finishing materials are the result of over twenty-five years of development in Lacrinoid's own works . . . they cannot be surpassed anywhere.



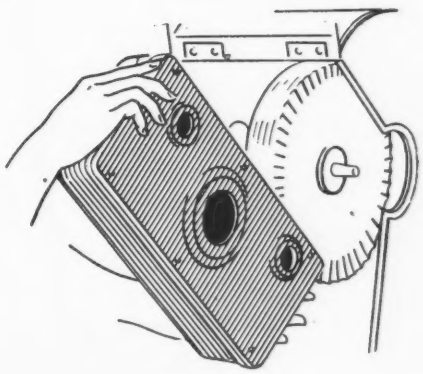
Granules for barrel finishing

for the barrel surfacing of plastics and wooden parts. The granules are of porous stone impregnated with a special bonding and lubricating compound. Their use prevents formation of dust and protects the material from abrasions. The granules can be reimpregnated after a period of use.



Polishing Cream No. 10 for barrel polishing

for the barrel polishing of small and medium sized plastics objects. A lasting, brilliant lustre is imparted with great speed and with the very minimum of supervision.



Bar Polish No. 11 for mop polishing

performs simultaneously the functions of (1) abrasion, (2) finishing and (3) glossing. It is fast in action and not only saves time but results in considerable economies in the replacement cost of mops.

Apply for descriptive leaflets which give fuller details of above materials

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High-purity solvent in the formulation of surface finishes.
Typical analysis:
Distillation range: 98% by vol. between 55.5 and 56.5°C.
Acidity as acetic acid: 0.0005% by wt. maximum.
Permanganate fading time: more than six hours.

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FURFURYL ALCOHOL, NONANOL, 'ALPHANOL' 79.

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B.105

What's on your mind?

. . . a plastic moulding that you want in double quick time . . . an intricate design that requires expert tooling up? . . . whatever your own particular problems may be, we are here to do the worrying for you.

Our experience has been gained through years of painstaking research into every aspect of plastic moulding . . . our skilled technicians have at their command the most up-to-date precision equipment in tool room and moulding shop—there are no gaps in our production line.

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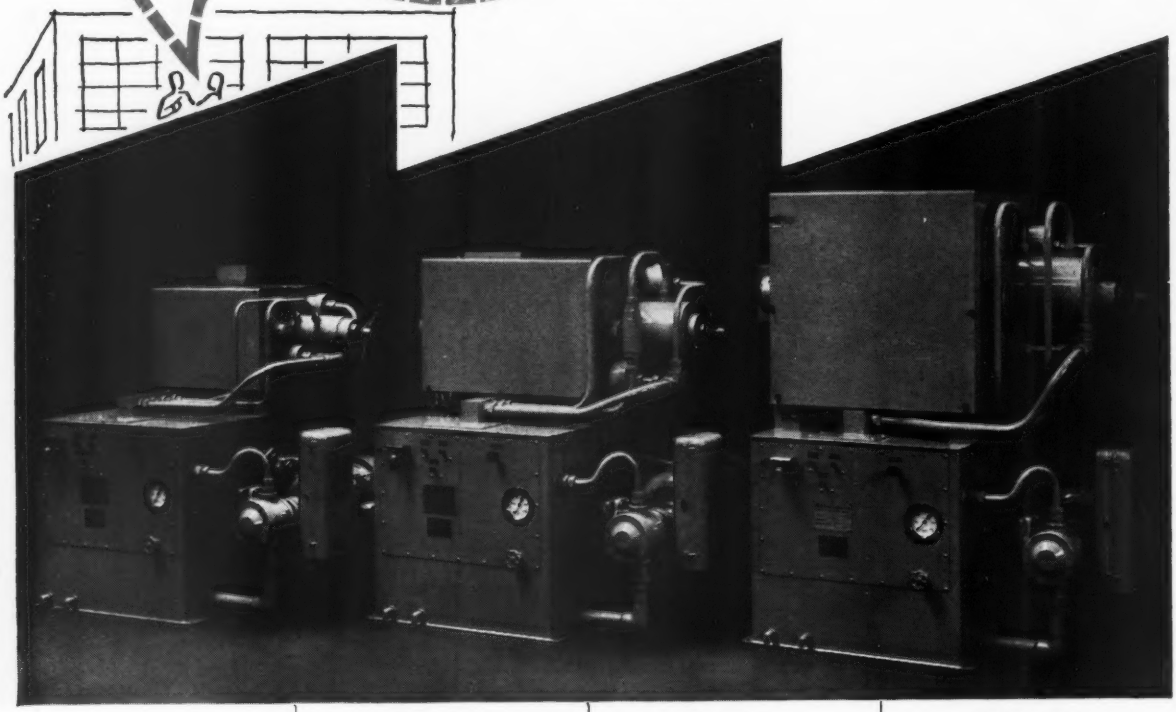
B

It's no trouble at all with

BIPEL

Horizontal Hydraulic Pelleters

The advantages of hydraulic pelleting combined with the speed of a mechanical pelleter and minimum maintenance requirements . . . that is BIPEL'S contribution to the job of making sound moulding preforms and making them quickly. How is it done? By using the main ram for compressing the powder only; filling and ejecting depend on rapid movements of the die and hopper.



	12 TON	35 TON	70 TON
Maximum dia. of pellet	1¾″	3″	4½″
Maximum strokes per hr.	2280	1260	720
Maximum fill	2″	3¼″	3½″
Overall dimensions	4′ 6″ x 3′ 6″ x 5′ 3″ high	4′ 6″ x 3′ 6″ x 6′ high	4′ 6″ x 3′ 6″ x 6′ 9″ high
Weight	20 cwt.	30 cwt.	35 cwt.

IN HYDRAULIC PELLETING, powder is compressed not by a blow as in a mechanical pelleter, but by a steady squeeze. In the BIPEL pelleter both the pressure 'dwell' and the amount of pressure applied can be accurately adjusted in a few seconds to suit the powder being pelleted. These in themselves are advantages: but there are others, for example:

1 No moving parts come between the punches, so the machine cannot suffer damage.

2 There is no powder spillage because filling takes place *in* the hopper.

3 The die is free during the squeeze so that the action is equivalent to applying pressure to both punches. This gives consistent density.

4 The maximum pressure cannot be exceeded so that there is no danger of a major breakdown due to the machine being over-stressed.

5 Adjustment of pellet weight is very simple and can be made while the machine is running.

6 Round, square, rectangular, and ring pellets, etc., can also be made.

7 Multiple punches can be fitted within the pressure capacity of each machine to increase production.

8 An auxiliary hopper with motorised agitator can also be fitted to feed very fine powder and semi-shock resisting materials.

The machine is completely self-contained with its own motor and pump (shop air supply is used for the controls). Since pressure only builds up during the squeeze and ejection, the motor is running light most of the time. Power consumption is remarkably small and maintenance charges are low.

Invest in BIPEL *Hydraulic Moulding Plant*

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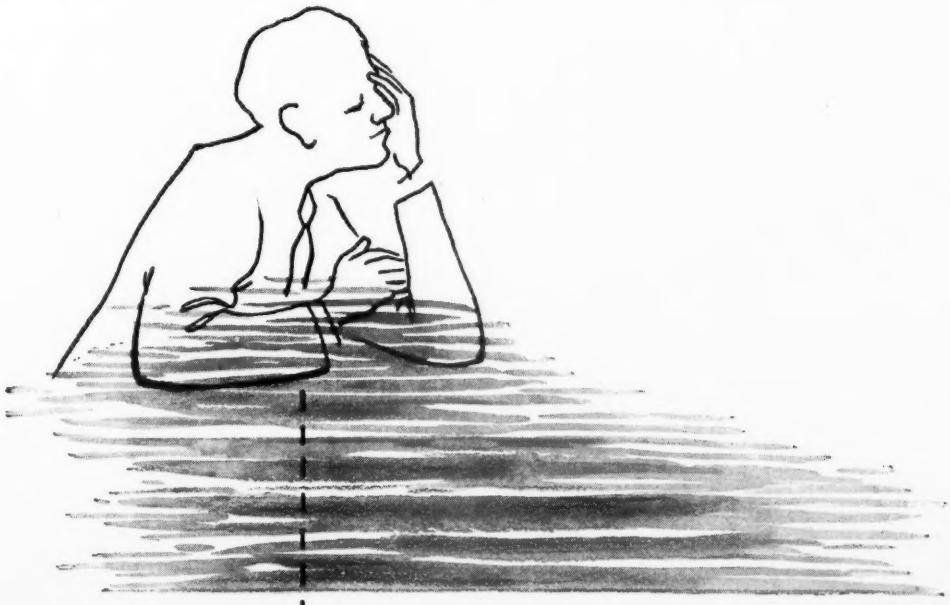
B.I.P. ENGINEERING LTD., STREETLY WORKS, SUTTON COLDFIELD, ENGLAND



What do you think of when you think of ***polystyrene?***

Cheapness, lightness and design-adaptability . . .
that's for sure. But the man who
really *knows* his plastics thinks of one thing more—
Kleestron Colorant Blend 604.
This brand of polystyrene, produced
in a fine new factory at Welwyn Garden City, England,
is—he knows—unsurpassed for *versatility*.
And that (plus polystyrene's other virtues)
is precisely why he chooses it.

the Versatile plastic

Supplied as fines, granules or a mixture of both

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BLEND 604

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C

HOT ON THE TRAIL

Are you harbouring scrap P.V.C., Cellulose Acetate, Polyethylene, Polystyrene or "Perspex"? We welcome all clues that lead us to these, or any kind of thermoplastic scrap and surplus material. Let us know the kinds and quantities you have to offer.

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"I think we are getting warmer, Mr. Ash."

"Not the weather, surely, Mr. Downs."

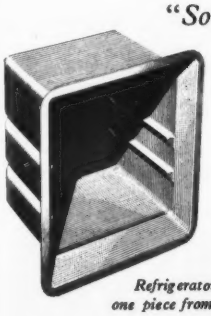
"*No, I refer to our latest achievement in plastic refrigerator interiors.*"

"You shouldn't mention the word 'warm' when talking about refrigerators, Mr. Downs."

"*Oh, indeed I should. The new interior* 18" x 12" x 12" *is the hottest job we've done so far. It has the liner, the breaker frame, the shelf supports and the condensation return rib all in one moulding.*"

"Quite an amazing long speech, Mr. Downs. But plastics forever, say I."

"*So do our customers, Mr. Ash.*"



Refrigerator interior moulded in one piece from glossy white PVC.

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Spray LOW TEMPERATURE MELTING NON-SHRINKING ALLOYS....

MAKES MOULDS FROM PATTERNS OF ANY MATERIAL

PERFECT REPRODUCTION

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100% METAL SALVAGE

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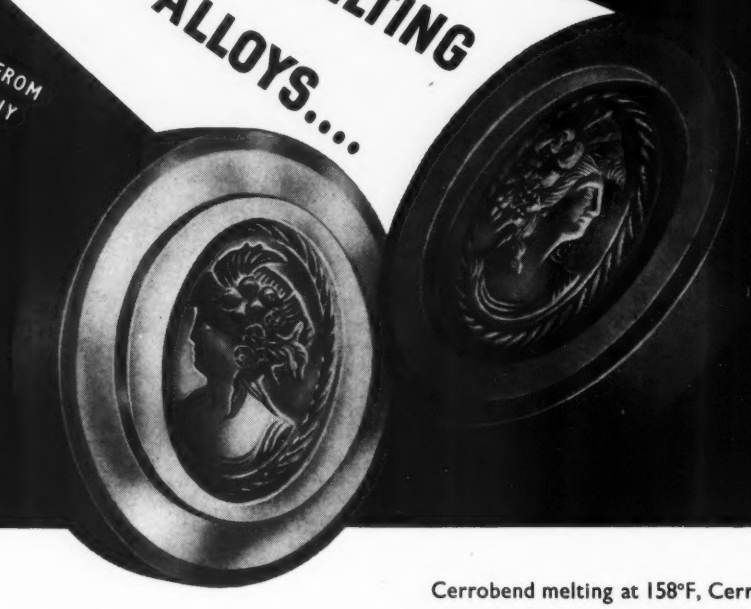

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Cerrobend melting at 158°F, Cerrobase at 255°F and Cerrotru at 281°F are easily sprayed against master models with inexpensive equipment. The resultant negative cavity, reproducing the finest detail, provides excellent mould for short runs in thermoplastics. After use moulds may be re-melted and metal fully recovered.

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Low-Temperature-Melting Non-Shrinking Alloys ALLOYS

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Beautiful

AND DURABLE

because this "Florestin" REGD. upholstery covering is made with Geon PVC

The "Florestin" PVC upholstery covering in this "Put-U-Up" combines the luxurious appearance of brocade with the exceptional wear-resisting properties of Geon PVC. It will stay elegant for a lifetime because even the hardest use cannot damage the Geon surface—and a damp cloth easily removes dust, fingermarks and accidental greasy stains. All furnishing materials made with Geon PVC—leathercloths, curtaining, wall-panelling—possess these combined qualities of toughness, durability and permanent freshness. Unlimited as to colour or design, they are easy to make up and combine well with other materials.

Illustrations by courtesy of Greaves & Thomas Ltd., creators of the "Put-U-Up", and Armoride Ltd., who make "Florestin" upholstery covering with Geon PVC.

Please write for descriptive booklet No. 51

Geon
Polyvinyl Materials

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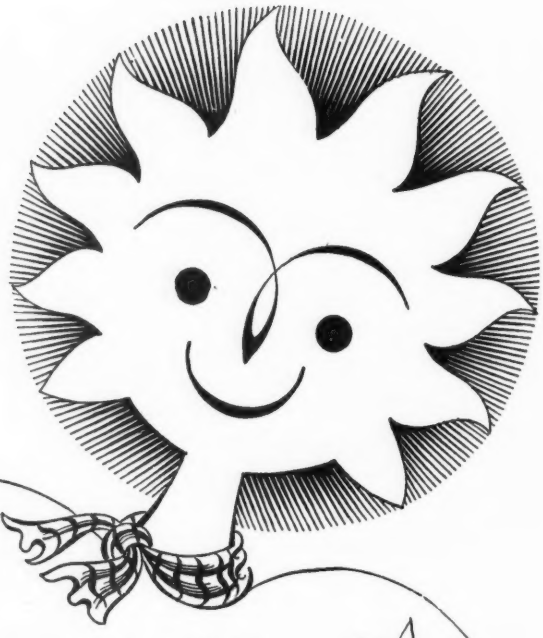
"Geon" is a Reg'd Trade Mark.

I go into action fast



Gas never keeps you waiting — dead-on controls deliver exactly the heat required, instantly. And the heat can be turned off just as quickly when the job's done. Since warming-up and cooling-off are eliminated, gas saves both time and fuel. Gas needs little attention—with automatic controls it can be left to do many jobs for you. Mr. Therm's remarkable efficiency, coupled with his unusual flexibility and cleanliness, make him the obvious choice to handle all industry's fuel problems.

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Mr. Therm burns to serve you

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Nylon has already established itself as an engineering material of great importance. Both in this country and in the U.S.A., nylon has *proved* itself, under the most stringent conditions, in many industrial applications.

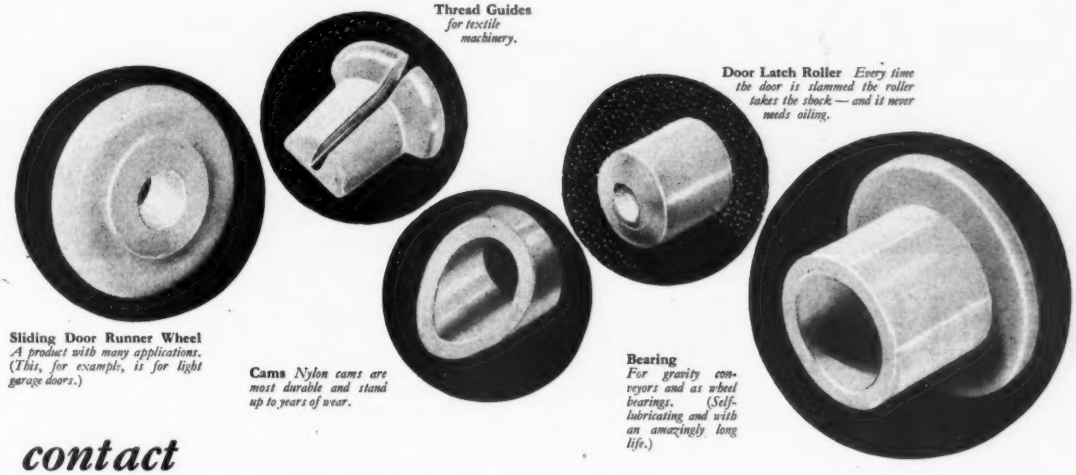
The advantages of the self-lubricating properties of moulded nylon when used as bearings or gears are obvious to the engineer; but this is only one of the many mechanical uses of this versatile material. A glance at the following list of its physical and mechanical properties will show you why NYLON has come to stay in the engineering world !

Extreme toughness
Excellent abrasion resistance
Stability at high temperatures
Very high strength/weight ratio
Good chemical resistance
Non-inflammability
Extremely low co-efficient of friction

Impact Strength —1-1.5 ft. lb. per ½" notch (B.S.S. 771)
Tensile Strength —10,000-11,500 lb. per sq. in.
Elongation —80-100%
Cross Breaking Strength —12-15 x 10^3 lb. per sq. in.
Hardness 12 Vickers Diamond
Specific Gravity — 1.14

All are average values measured on injection moulded test specimens.

We can supply a wide range of blanks for your own test purposes



Thread Guides *for textile machinery.*

Door Latch Roller *Every time the door is slammed the roller takes the shock — and it never needs oiling.*

Sliding Door Runner Wheel *A product with many applications. (This, for example, is for light garage doors.)*

Cams *Nylon cams are most durable and stand up to years of wear.*

Bearing *For gravity conveyors and as wheel bearings. (Self-lubricating and with an amazingly long life.)*

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the plastics people—about NYLON

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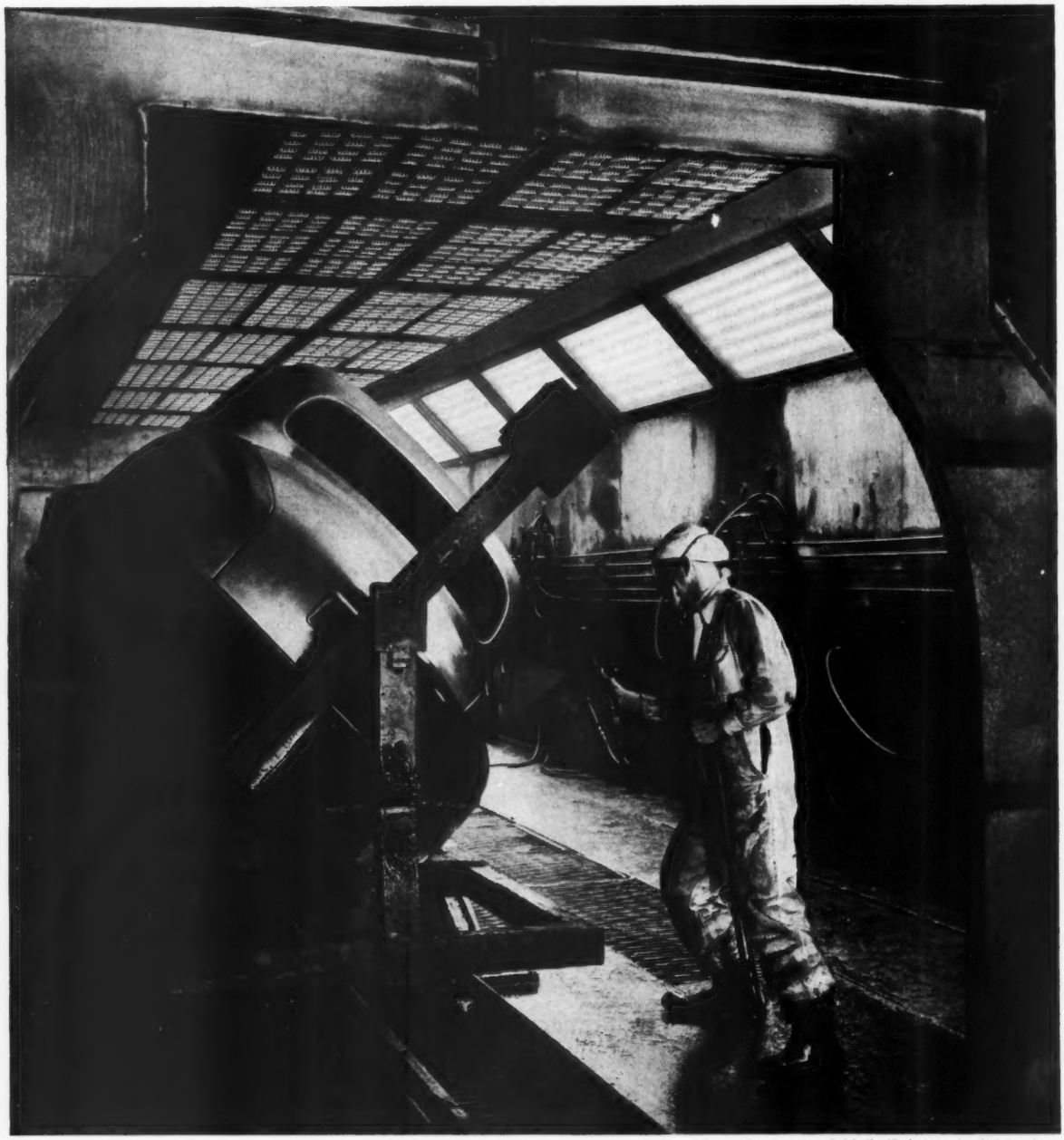


Rover Car Factory, Solihull. High intensity lighting in a body spray tunnel by fluorescent lamps in a glazed enclosure.

Tailored for the job

The lighting of many processes is vital to the smooth and rapid flow of work and to the quality of the finished product. For example, poor lighting could make a spray tunnel into a bottle-neck — each job taking a little too long, a little portion missed, a return to the spray line — and so the whole production line marks time. Whatever form it takes, good lighting not only helps to provide a satisfactory working environment but is an active production tool.

Fluorescent lighting is as good as daylight — only more consistent. It is efficient; it is economical; and it is *flexible*. You can ' tailor ' it, easily and exactly, to the special requirements of production at all stages.

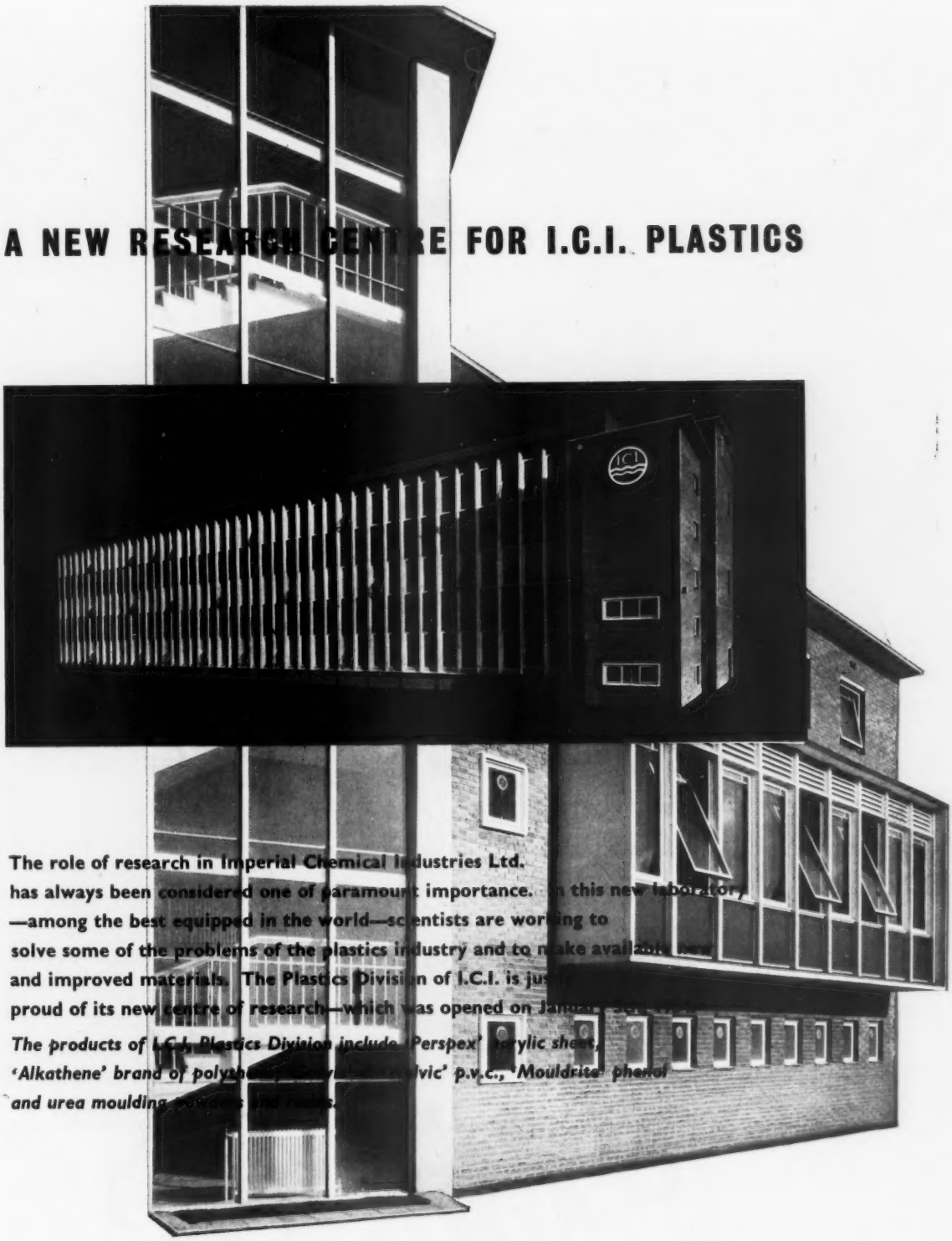
HOW TO GET MORE INFORMATION

Your Electricity Board will be glad to advise you on how to use electricity to greater advantage — to save time, money, and materials. The new Electricity and Productivity series of books includes one on lighting — " Lighting in Industry ". Copies can be obtained, price 9/- post free, from E.D.A., 2 Savoy Hill, London, W.C.2, or from your Area Electricity Board.

Electricity for PRODUCTIVITY

Issued by the British Electrical Development Association

A NEW RESEARCH CENTRE FOR I.C.I. PLASTICS



The role of research in Imperial Chemical Industries Ltd. has always been considered one of paramount importance. In this new laboratory —among the best equipped in the world—scientists are working to solve some of the problems of the plastics industry and to make available new and improved materials. The Plastics Division of I.C.I. is justly proud of its new centre of research—which was opened on January

The products of I.C.I. Plastics Division include 'Perspex' acrylic sheet, 'Alkathene' brand of polythene, 'Welvic' p.v.c., 'Mouldrite' phenol and urea moulding powders and resins.

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1

Export enquiries should be addressed to IMPERIAL CHEMICAL INDUSTRIES LTD., Plastics Division · Black Fan Road · Welwyn Garden City · Herts · England

P.560

CRAYMAC brings a new range in

Texturised finishes

They give that silky, luxurious look that's the basis of the new glamour in rainwear. In six muted shades the new Craymac P.V.C. sheeting is really strong—can be welded or sewn and styled at will.

WRITE NOW FOR PATTERN FOLDER

Rainwear stylists and users of P.V.C. sheeting are invited to send for a new shade folder. Samples of all shades and gauges in translucent, opaque, metallic or laminates gladly sent on request.

THE GREENWICH LEATHERCLOTH CO. LTD.

St. Mary Cray, Kent, England.

Telephones · Ravensbourne 4674/5 & Orpington 5671.

'Craymac' is manufactured to British Standards Institute Specification No. 1763 by one of Britain's largest producers of P.V.C. sheeting.

CRAYMAC

P.V.C Plastic Sheeting

Serial No ★ 1923
BRITISH
GOOD HOUSEKEEPING INSTITUTE
GUARANTEES
REFUND OF MONEY OR REPLACEMENT IF NOT IN CONFORMITY WITH THE INSTITUTE'S STANDARDS

A Greenwich PRODUCT

An Embarrassing Situation

Our close association with deities like Jupiter, Neptune, Hercules and Venus has resulted in their taking increased interest in our manufacturing organisation.

Between ourselves, it's a bit embarrassing at times—especially when Jupiter recently wanted to see what would happen if he ejected a few of his thunderbolts into our Stills.

Then Venus asked if we could remove the top of a Still to enable her to re-act her rising from the sea in her birthday costume near Cyprus (some thousands of years ago) for the benefit of us and our Foremen.

Fortunately, our Works Censor, in consideration for the high standards of staid respectability pervading our Works, clamped down on the idea—by persuading the lady that mixtures of phenol, formaldehyde, etc., might be so detrimental to her skin as to destroy her beauty.

Mind you, we are pleased that these ancient deities have "come to earth", and have honoured our Works with their presence. Our only difficulty is trying to make them realise the time-gap between their mythical existence in the days of ancient Greece and Rome and our Firm, which though existing in the PRESENT is constantly ahead of it in research and practice.

Could some scientist—well versed in the fallaciousness of Time (as at present understood) assist us?

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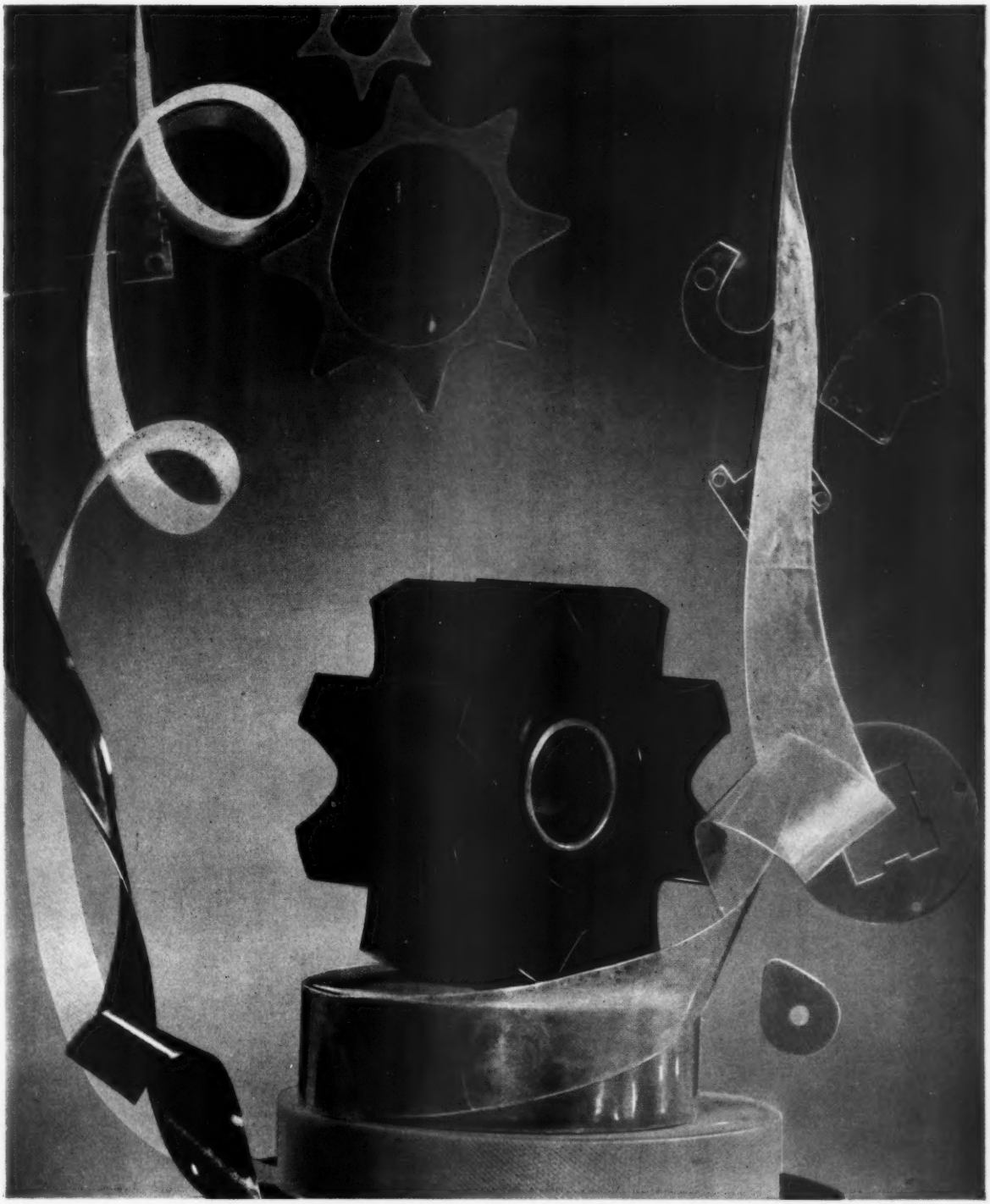

Examples of our many activities. The pump impeller is a Panilax Resin Moulding and is supported upon rolls of Mica tape and Empire tape. The punchings include Micanite, Paxolin Laminated and Mica.

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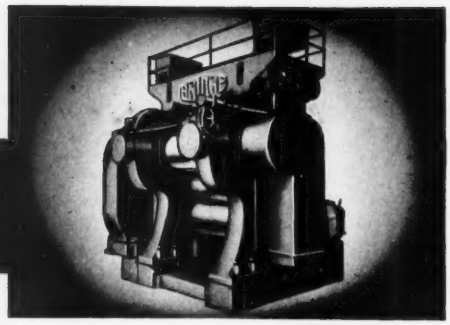

Precision Calender with three superimposed and one offset roller. Flood lubrication.

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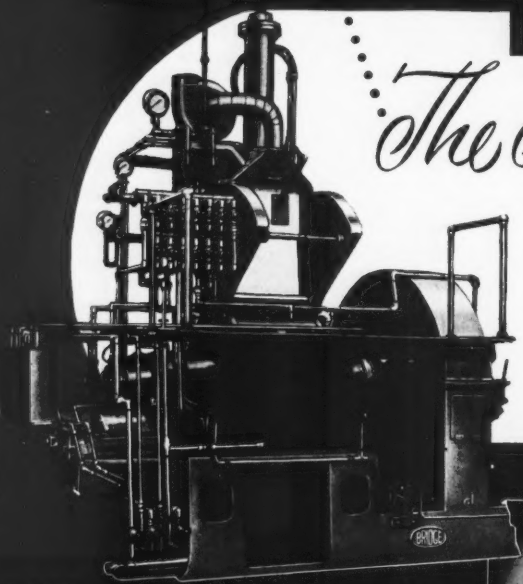
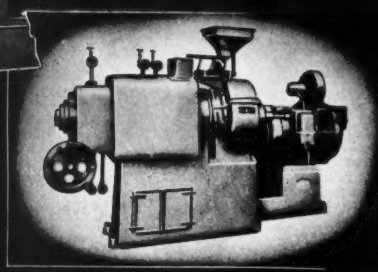


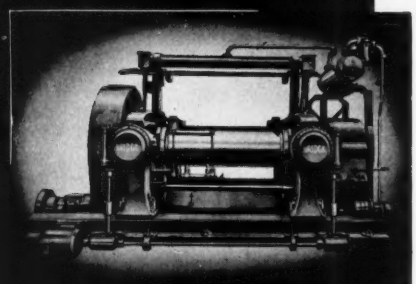
The Bridge — Banbury Patent Mixer. (1)

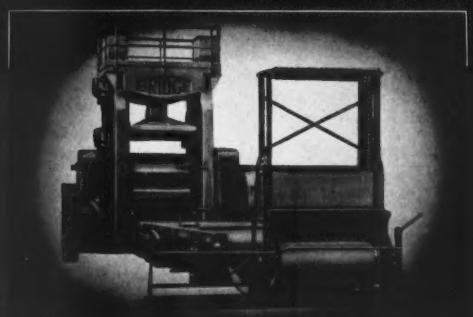


4½" Cold Feed Plastics Extruder. (3)

Precision Calender with four superimposed rollers. Flood lubrication. (2)

High temperature 22" x 60" Plastics Mill with flood lubrication. (4)





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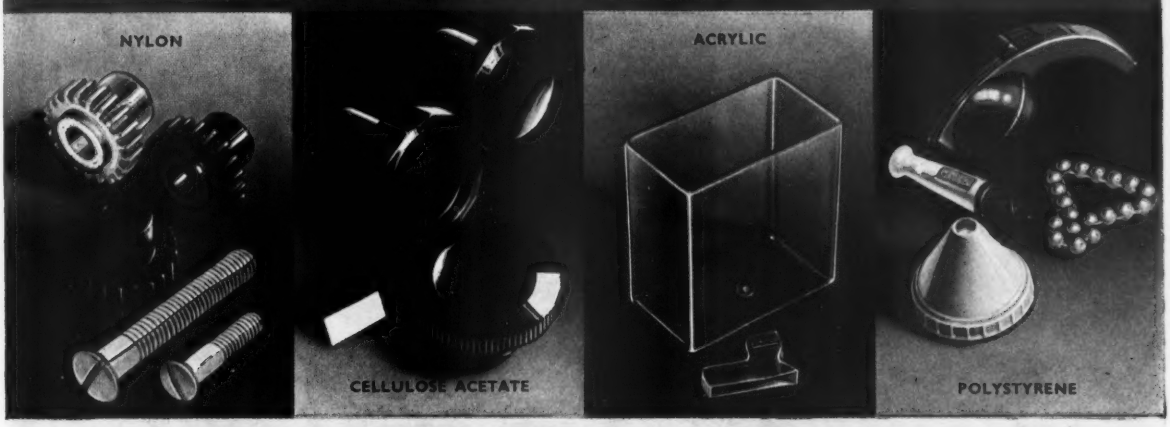
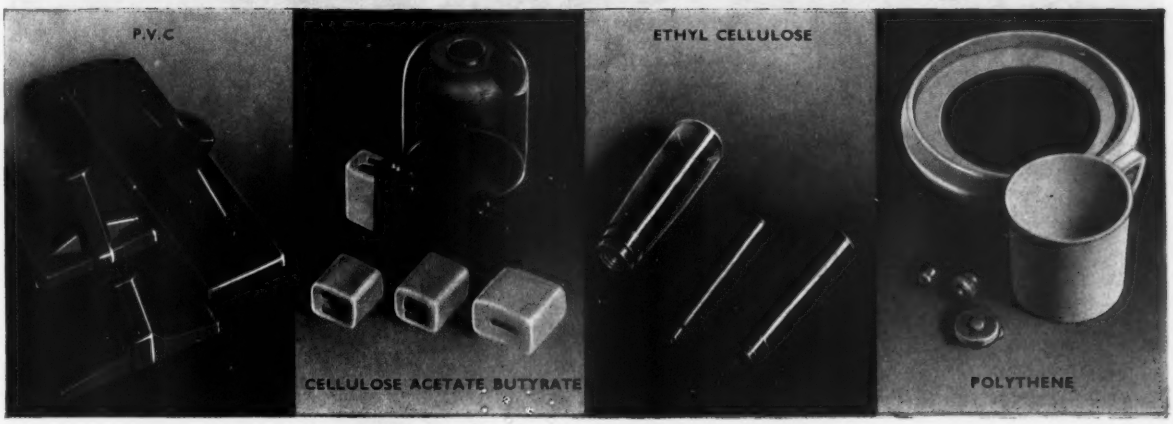
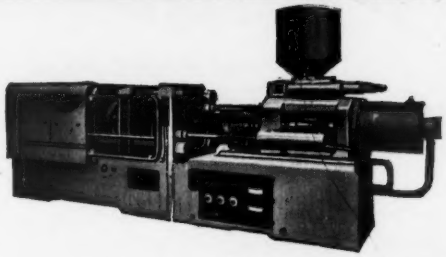


injection mouldings





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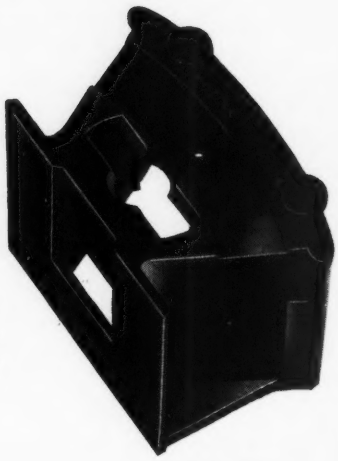
the case of the BROWNIE 127

No need to hear this *in camera*. It's no secret. A compression and injection job, it called, if we may say so, for superb accuracy and finish, particularly as it was wanted for a Kodak camera. There was the case 'body', the cover to fit the case and various internal parts, all of which were precision-moulded to narrow limits.

VERDICT — just another example of the work of an expert tooling and moulding service.

Can we help you, too?

TECHNICALLY, a high degree of accuracy was achieved to ensure that the cover fitted the case perfectly. Both cover and case were compression-moulded in black wood-filled Phenolic material giving a black lustrous finish. The case body was produced on three 2-impression side ram tools to simplify moulding complicated by innumerable undercuts. Various internal parts of the camera were injection moulded.



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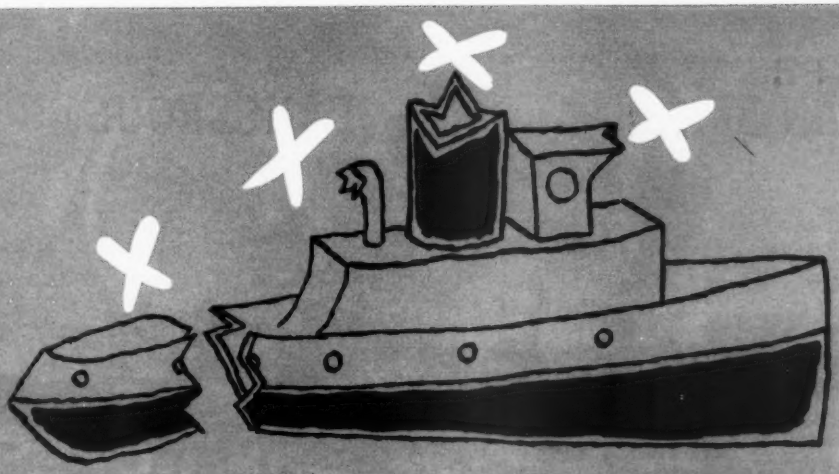
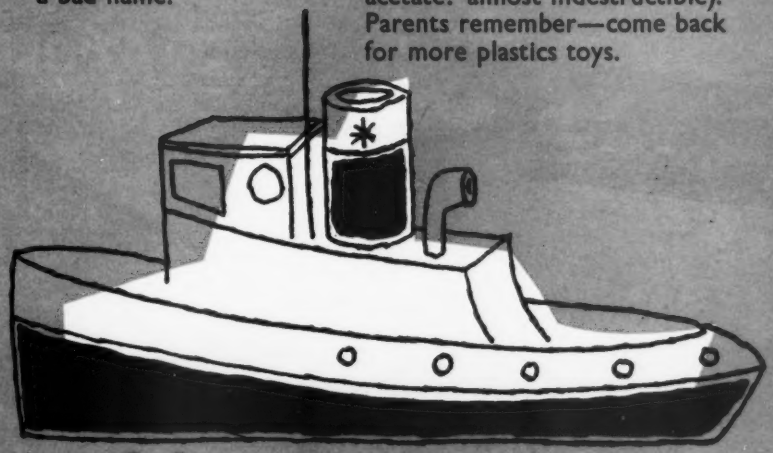


cut–

When this toy is broken (which will be soon) there'll be sharp, jagged edges —edges that can cut a child. Parents remember—and all plastics toys get a bad name.

or come again?

This toy won't break—in transit or in the nursery. And it can't break with a jagged edge (because it's made of Courtaulds' cellulose acetate: almost indestructible). Parents remember—come back for more plastics toys.



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Or you're convinced that it can't be?
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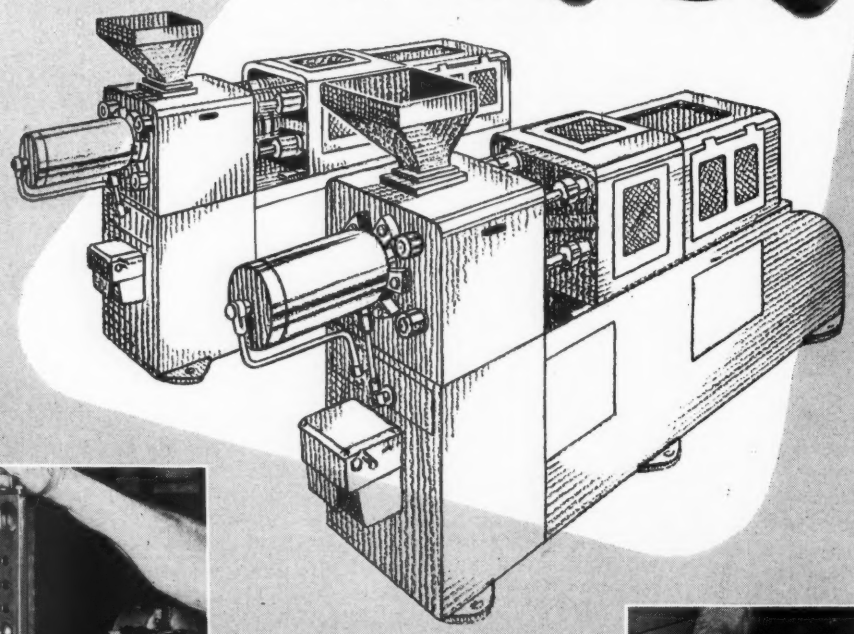
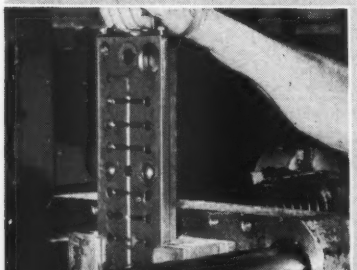
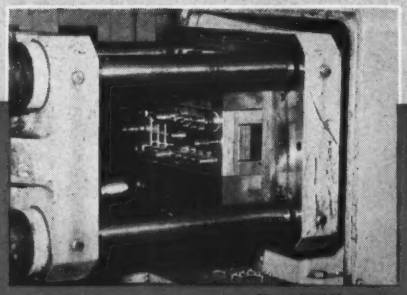
This has recently been achieved by the Plastics Division of E. K. Cole Ltd. on behalf of The National Cash Register Co. Ltd. of Dundee. Two Windsor S.H. 4 oz injection moulding machines are employed, each operating with a thermoplastics material of a different colour. First the outer shells of the keys are moulded on one machine, and each shell then acts as the tool for the moulding into it of the numeral in another colour, using a second S.H. 4 machine



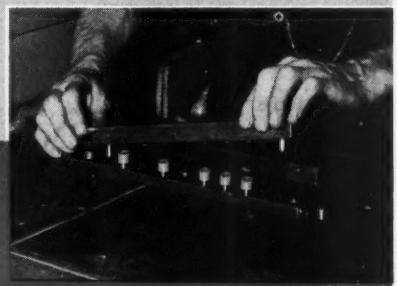


The Portable plate with the 'shells' is here seen being fitted into the second machine ready for colour moulding.



View after removing the portable stripper plate (not shown) which still holds the moulded 'shells'.

Photos by "Plastics"



Operator of second machine proceeds to mount bolster plates prior to second moulding operation.

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FM.2 BLACK

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BULK FACTOR	3.5
PELLETING PROPERTIES	CANNOT BE PELLETED
SHRINKAGE (inch/inch)	.005—.007
DENSITY OF MOULDINGS	1.35
IMPACT STRENGTH (ft./lbs.)	0.28—0.32
TENSILE STRENGTH (lbs./sq.inch)	6000—8000
WATER ABSORPTION (mgms)	110—150
ELECTRIC STRENGTH @ 90°C. (volts/mil)	50—80
ELECTRIC STRENGTH @ 20°C. (volts/mil)	150—250
SURFACE RESISTIVITY (megohms/cm²) (1) FRESHLY MOULDED (2) AFTER 24 HRS. IN WATER	10^4—10^5 10^3—10^4
VOLUME RESISTIVITY (megohms/cm³)	10^5—10^6
CURE : SECONDS TO OBTAIN A BLISTER FREE CUP	70—75
MOULDING TEMPERATURE	300°F—330°F

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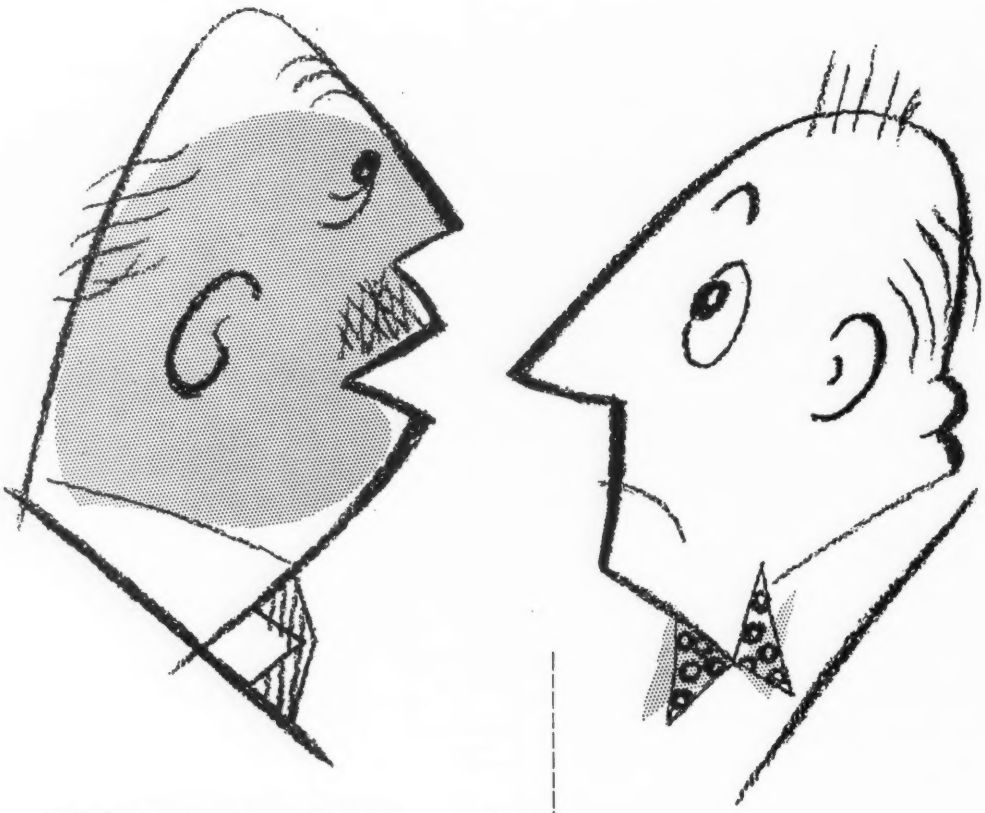

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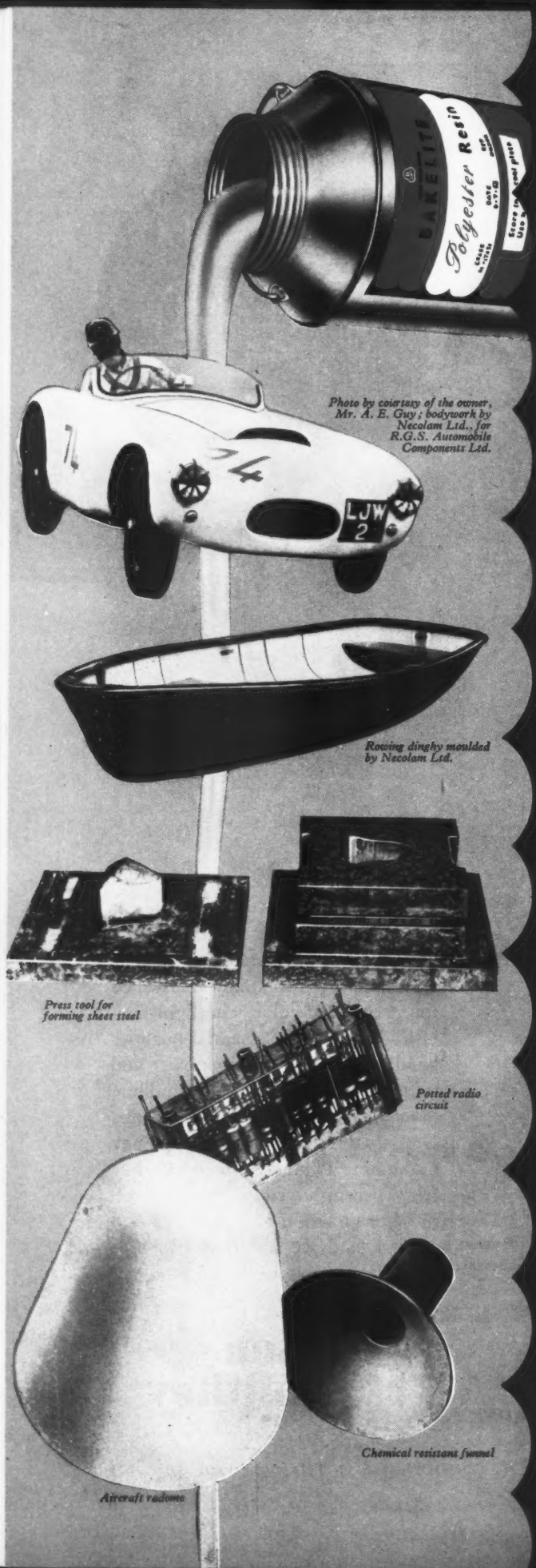
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2
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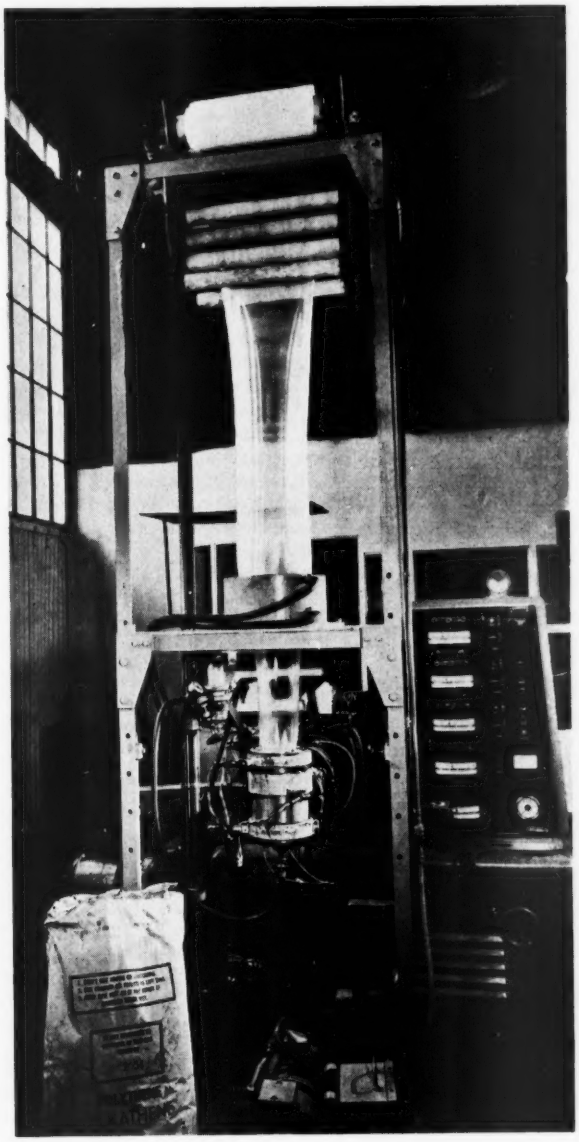

Development work in progress on the extrusion of polythene lay-flat tubing at the works of the Projectile and Engineering Co., Ltd., Acre Street, Battersea, London.

EDITOR: M. D. CURWEN, B.Sc., A.R.I.C.
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Plastics

VOL. XIX. No. 200 MARCH, 1954

EDITORIALS

First Work on Scrap

DURING the second half of 1953 we published a number of editorials relating to the use of " scrap " from the injection moulding process from the viewpoint that while it is known that the various thermoplastic raw materials suffer a measure of degradation, little or nothing has been done systematically to estimate that degradation quantitatively and qualitatively on the practical scale. Furthermore, since scrap—gates, sprues and rejects—is often recycled (indeed text-book definitions of a thermoplastic suggest that it can be recycled indefinitely) it seemed to us apposite to suggest that such an analysis would prove interesting and perhaps economically useful to the industry as a guide to quality.

As a result of our editorials, we published a number of letters from workers in the industry, some admitting the importance of obtaining information on the subject, others denying its value on the basis that the use of scrap is always accompanied by admixture with high proportions of virgin material. Consequently, it was said, since the proportion of degraded material is so small the problem was scarcely worth while raising.

This may be so and indeed we hope it is really not worth while worrying about except from pure inquisitiveness, which the industry should possess in large measure. On the other hand, since such an argument was raised without any real theoretical and practical knowledge we were back where we started.

No doubt there are special jobs in which no scrap is recycled at all, a truth which in itself is an admission that further degradation is inimical to quality. The argument that only small proportions of scrap are admixed with virgin material and recycled cannot be accepted as being universal practice, nor can the statement that the proportion of weight of scrap to weight of finished moulding is always low; the weight of scrap can obviously be as high and even higher than the weight of the moulding and economic conditions may force the hands of many to affect changes in procedure as a consequence. It does not require profound business ability to realize that selling scrap for less than the cost of virgin material is bad business if the scrap is regarded as good as virgin material, as some text books seem to imply. Vagueness is general and so far there has been no official or authoritative advice to clarify the matter one way or another, in this country or elsewhere. And vagueness over definitions and vagueness in practice is not a characteristic that should be tolerated in our industry.

There is now, however, the possibility of some coherent information being gathered together in the U.S.A. and on page 94 of this issue of *Plastics* we have pleasure in publishing the details of the first part of a study on the subject of " Thermal Degradation of Polymers During Moulding," by H. R. Frisch of Syracuse University and V. T. Stannett of the State University of New York, and which first appeared in the January issue of the Journal of the Society of Plastics Engineers.

The study is the result of a visit paid to this office in November, 1953, by Dr. Vivian Stannett, who, before he left this country some six years ago to continue his studies in the U.S.A., had done much valuable work in the factories of Erinoid Ltd., and its associated company, Utilex Ltd. We put forward our general views on the subject and on the possibility of examining it from both the theoretical and practical standpoints and expressed the hope that some authority would eventually publicize the data obtained. At the least, the work would provide an interesting mathematical, chemical and physical exercise for somebody and at best might also clarify the situation one way or another and even prove of economic value to the industry. Dr. Stannett agreed and said he would like to inaugurate such a series of experiments at the State University of New York, where he is assistant professor, collaborating with a well-known physicist on the mathematical part of the problem. The paper we publish in this issue represents the latter aspect. Obviously it is more interesting in its present form to physicists and other scientists than to moulders, who will require its correlation with the experimental work on the injection machine which is now in progress. This latter work is perhaps the more onerous from many points of view, for no doubt it entails the continued recycling of a thermoplastic material under carefully controlled conditions and the carrying out of physical and chemical analyses after each cycle to note the degradation, if any, that has taken place.

Whatever the results may be, we offer our thanks to both workers for what is perhaps the first deliberate study of the problem and to the Society of Plastics Engineers for its publication. Our special congratulations are for Dr. Stannett for the celerity with which the work has begun.

Nationalization Threat to the Chemical Industry

OUR largest chemical entity, Imperial Chemical Industries, Ltd., has published its reply to the Labour Party proposal of October, 1953, contained in " Challenge to Britain," for a substantial degree of public ownership of the chemical industry which the Labour Party claims to be under tight monopoly control. The Party's main concern is with heavy chemicals, explosives, dyes, plastics and petro-chemicals.

We wonder if the Labour Party has received a correct picture from its chemical " experts " of the extraordinary complexity of the chemical industry. It proposes to take over much although not all and this will be achieved " in such a way as not to disturb the smooth functioning of the industry at home and abroad." We can conceive no expression more certain to produce utter dismay among knowledgeable workers than this ingenuous one. The tongue only is smooth.

The reply by Imperial Chemical Industries, Ltd., entitled " The Chemical Industry and ' Challenge to Britain ',' " is a carefully considered and well-balanced refutation of the attacks made on the industry. The main points in " Challenge to Britain " are taken and dealt with *seriatim* and we give some of them herewith.

" The new economic plan will make fresh demands on the industry." The " plan " includes attempts to reach agreement with the U.S.A. to keep raw material prices steady, pressure

on the Americans to remove their restrictions, policy of discrimination against dollar goods, expanding East-West trade. But there is nothing about a real plan. This is merely a statement of objectives, of aspirations and broad proposals without any reference to the substantial element of human freedom that exists.

"Chemical production must expand to keep pace with enlarged requirements." The history of the chemical industry is the most outstanding example of continued expansion among all our industries and greater expansion is on foot.

"We must expand home chemical production wherever possible to replace imported chemicals." Here we have an example of the common and dangerous international desire to attain self-sufficiency without realizing the limitations of a small island with few basic raw materials. The value of chemical imports (£41 million) compared with exports (£138 million) is not so significant as is implied. Moreover, many of the imports simply do not exist here and we must have them.

"We must develop rapidly the new industries based on synthetic fibres and plastics which open up possibilities of large scale replacement of traditional and costly raw material imports." So far as synthetic fibres are concerned their cost is such that cotton, wool and rayon could not be replaced in the foreseeable future, even though the manufacture of the synthetic materials is expanding considerably. As for plastics, we have expanded phenomenally, for capacity is about 10 times that of 1938. Furthermore, none of them can be classified categorically as substitutes, the traditional materials hold sway because of lower costs and because the quantities used cannot conceivably be matched by plastics.

"At present the chemical industry is under tight monopoly control." There is no foundation that the chemical industry is under tight monopoly control, although there is a monopoly in certain products. There are hundreds of chemical factories each working in keen competition. Where monopoly exists it has arisen through specialization arising from economies of large-scale production, selling at such low prices that a newcomer would find wholly unattractive.

These points and many others taken from "Challenge to Britain" are elaborated in the I.C.I. pamphlet.

Moulding Powder and Shot

Technical Teaser

There is a most useful publication issued by a Government scientific department under the title of "Unanswered Questions," which seeks to collect and distribute to inquirers the answers to certain difficult problems which have hitherto remained unsolved. The idea is that some worker somewhere may have worked and solved the same problem. The importance of such a service was commented upon in these pages a year or two ago and is again emphasized by the receipt in this office of the following problem: "We require to lap a $\frac{1}{8}$-in.-wide face on a machined ring of polytetrafluorethylene about 2 in. diameter. The face must be made flat to within 0.00002 in. The thickness of the ring is $\frac{7}{16}$ in." What is required is clearly an optically flat surface, and while such extreme accuracies are produced every day in polymethyl methacrylate by at least two companies moulding or casting lenses and probably could also be produced on polystyrene and nylon, we are faced here with the very intractable p.t.f.e. available only, we believe, in sintered form, obtained as in powder metallurgy from finely divided powder. It seems, therefore, that moulding against an "optical flat" would be useless and it has been suggested to me that the only other method would be to diamond lap at low temperatures, when the p.t.f.e. would be hard enough to conform to such treatment. Thus, if we have a container with mercury in it and freeze it with solid carbon dioxide or liquid nitrogen, an "optical flat" would be obtained and the p.t.f.e., similarly cooled, could be diamond-lapped against it. One question arises: What would happen when the temperature returns to normal with a rise of more than 80° C.? Can any reader help?

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Glass! Glass! Glass!

That delightful writer of gardening topics in *The Observer*, the Hon. V. Sackville-West, has aroused the ire of a reader of that journal for her favourable comments on plastic cloches. The angry reader in this case is a manufacturer of glass cloches which is perhaps understandable. However, she sticks to her guns and in a recent issue gives "fors and againsts" for the plastic types. "In favour of plastic. It is virtually unbreakable; all in one piece and thus incapable of disintegrating when shifted; lighter in weight than glass and consequently more portable; easier to store. . . Against plastic, I suspect that it would get discoloured in course of time, thus losing its transparency and that it might retain moisture, i.e., condensation, longer than glass. . . Final objection to plastic cloches; they are initially more expensive than glass." Which is all very fair and encouraging I'm sure. On the other hand she appears to agree with the angry manufacturer that the plastic cloches are for the amateur gardener and not for the big market gardener; the angry manufacturer also insists that "properly used cloches are moved not carried" (there's a subtle distinction somewhere here), hinting that glass has as long a life as plastics. What nonsense this is! The market gardener or rather his workers are like other humans and the average garden where glass is used contains enough broken pieces by the time summer comes round to start a small glass factory. The plain fact of the matter is that the market gardener would love to have plastic cloches because they don't break; nor do they discolour and scratch very much more than glass. Earth and grit go for glass too, for there's always the wind. But the main point about plastic cloches is their long life and unfortunately the big gardener generally cannot afford the capital outlay for hundreds or thousands of them.

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Polythene Production

In the January issue of *Modern Plastics* the American journal, reference is made to the production of polythene, gives the U.S.A. total production figures in 1953 as 60,000 tons and states that Imperial Chemical Industries in England, the original producer, has a 2,700 ton plant in operation. This latter figure is a travesty of the fact and a dangerous one, for users in this country and in Europe may wonder what would happen if demands for polythene grow. In our January issue we gave a reasonably accurate estimate of production in this country of 5½ times the American estimate, namely, 15,000 tons per annum. In actual fact the capacity of the I.C.I. plant is nearer 18,000 tons a year—not a negligible figure for a small country which has had to operate in the past without petrochemical works for making ethylene gas. What is even more important to emphasize is that I.C.I. will increase production considerably in the near future—we believe by about 100 per cent. That the state of affairs is not so dismal as the American paper indicates is borne out by the fact that I.C.I. exported 2,000,000 lb. of polythene to the United States in 1953. The same journal states that polythene will always be higher in cost in this country than in North America because costs of petroleum from which ethylene is derived, are greater. It also gives I.C.I.'s price as 50 cents a pound and Du Pont's price as 49 cents in 1953, recently reduced to 46 cents. Not a great difference, in view of the large American production and in view of our difficulties; it is one that may become smaller when our petroleum chemical factories get really going.

DOGSBODDY.

(*A Shell photograph*)

Production Story

The Shell emblem, a familiar sight in many countries, is now fabricated from Perspex, by the low-pressure moulding technique. The article which follows describes the various stages in its manufacture at the Dunstable works of Thermo-Plastics, Ltd., and comments on the low-pressure technique. Notes are also included on the moulding of a refrigerator interior from semi-rigid p.v.c. sheet.

ALTHOUGH the forming of thermoplastic sheet materials under low pressures is by no means a new technique, this branch of the industry has expanded rapidly since the late war. This increase has been due to the availability of a wide range of new thermoplastic materials in sheet form, including p.v.c., polystyrene and polymethyl-methacrylate, thus widening considerably the potential markets for low-pressure mouldings by virtue of the diversity of properties possessed by these new materials, such as chemical resistance, electrical properties and attractive colours. Even today, intensive research is in progress with the object of increasing the mechanical and electrical properties of these materials, to suit them for even wider fields of application, and with the progress that has already been made, it is hardly surprising that fabricators all over the world are studying the low-pressure technique with great interest.

The economic advantages for the technique have been posed on many occasions; low-pressure moulding equipment is cheaper to build and cheaper to run than its comparable equipment in the high-pressure field. In addition, and equally important, for short runs tools can be easily fabricated from wood or plaster of Paris, for long runs from alloy die castings and paper-base phenolic sheet, with the result that tool cost is frequently a small fraction of that of hobbed or machined high-pressure tools.

The low-pressure moulding of thermoplastic sheets, as compared with the low-pressure laminate moulding of thermosetting materials, shows certain advantages for the former, if we discard for the present argument that of mechanical strength. The latter lack the density which results from the high pressures used, with consequent deficiencies in electrical properties, moisture absorption and elongation. Impact strength is probably better in the case of low-pressure as compared with high-pressure mouldings.

In the thermoplastics field, however, the sheet materials that are employed have already been processed to the requisite density either by casting, slicing or hot pressing. The physical conditions involved therefore in the manipulation of such sheets is fundamentally different from that which is involved in the high-pressure technique. The technologist need not fear any appreciable loss in, for example, electrical or water resisting properties. He has, however, to consider very carefully the stresses which are set up during the low-pressure moulding of sheet, particularly where deep draws are involved. Molecular distortion may be such as to seriously weaken the mechanical properties of the sheet material, a possibility that is shared by the vacuum-forming technique discussed elsewhere in this issue. Thermo-Plastics, Ltd., of Dunstable, have largely pioneered the low-pressure moulding technique, and have employed it with all of the presently available sheet materials. They have acquired considerable experience in the changes which sheet materials undergo during the forming technique and have investigated thoroughly the heating problems that are involved in bringing

Fig. 1. (Above) Pre-heating oven with batteries of infra-red lamps.

Fig. 2. (Right) Mould assembly, showing upper platen.

Fig. 3. Lower tool.

Fig. 4. Removing moulding from press.

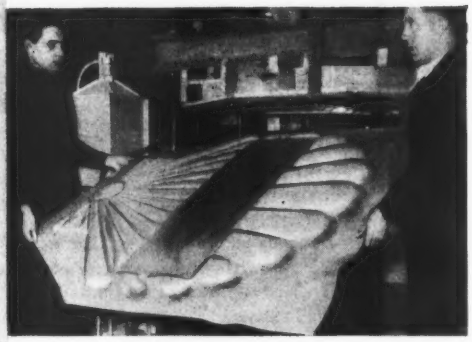


Fig. 5. Moulding ready for trimming.

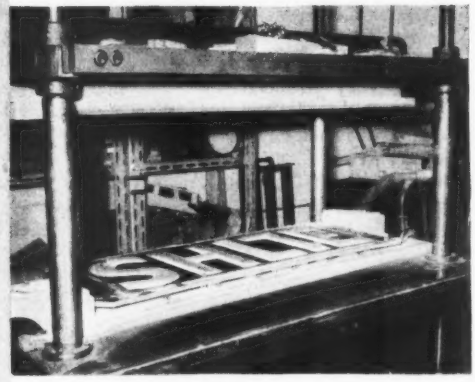


Fig. 6. Mould assembly for letters.

sheet material to the right temperature for low-pressure forming.

This article deals with two typical examples of products of the Dunstable factory of Thermo-Plastics, one of which is probably the biggest low-pressure moulding in current production, and the other a moulding which calls for a considerable depth of draw, in fact 9 in., with a sheet material of $\frac{1}{8}$ in., thickness.

Fabricated for the Shell Petroleum Co., Ltd., the Shell signs are moulded by low pressure from sheets of Perspex 5 ft. square, in two types. The first in single-sheet size, made from $\frac{3}{16}$-in.-thick Perspex, the second a "double" size, involving a deeper draw in moulding, made from $\frac{1}{8}$-in.-thick Perspex. A single sheet of the material weighs over 20 lb., obviously beyond the scope of normal injection moulding. These signs are at the moment used exclusively abroad, in some 44 countries.

Fig. 1 shows the heating oven, powered by batteries of infra-red lamps, into which the sheets of Perspex are brought to the requisite temperature, approximately 120° C. The rate of heat built up is controlled to coincide with the pressing time called for in the press. In Fig. 2 can be clearly seen the press with tools clamped in place. The upper half of the tool is mounted on stout wooden blocks and comprises a combination of metal slats designed to bring the sheet into intimate contact with the configuration of the bottom tool below. The press itself develops a pressure of 8 tons on the moulded area, maintained by an independent accumulator and pump.

The lower half of the tool can be more clearly seen in Fig. 3 and is constructed from zinc alloy mounted on wood; although of stout construction, it is evident that the tools are relatively inexpensive to produce and the simple clamping devices that are employed provide for quick changes from one production line to another.

Fig. 4 shows the press open with two operators removing the cooled and pressed sheet. In Fig. 5 the moulded unit can be clearly seen; it is a feature of the mould design employed here that the upper surface has lost none of its gloss, due to the fact that the upper half of the tool only touches the sheet where it is necessary to force the sheet over the raised contours of the lower tool. The centre space is left flat to provide for the fixing of the letters, the tool for which is shown in Fig. 6; these, fabricated in batches from $\frac{1}{8}$-in. sheet Perspex are subsequently cut out as shown in Fig. 7. By ingenious design, the minimum of material is wasted in the manufacture of these letters.

Rough flash is removed by bandsaw; the moulding is then placed on a routing jig and accurately routed to the required shape. A bevel is put on to the edge by a radial arm router. The use of very high-speed tools reduces the risk of degradation of material by heat build-up.

The next operation is the affixing of the letters, which are

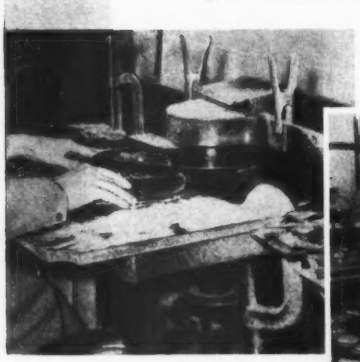


Fig. 7. (Above) Cutting out letters from moulding.

Fig. 8. (Below, left) Positioning letters.
Fig. 9. (Below, right) Clamps in place.

Fig. 10. The letters cemented in place, the moulding is removed.

Fig. 11.—View of main assembly line.

Fig. 12 (Right, above).—Signs are packed for despatch.

positioned with the aid of a light-alloy jig, and specially designed work tables shown in Fig. 8. The work table is fitted with a series of edge clamps to facilitate the cementing of various strengthening strips and has over it a stout iron bar from which clamps are fixed to apply the necessary pressure to the letters seen in Fig. 9. A solvent is used to provide a stout bond between the layers and the main structure. In Fig. 10 can be seen the removal of the unit by two operatives.

The demand for these signs is sufficient to warrant the maintenance of extensive production lines since they are exported in considerable numbers, and in Fig. 11 on the right side can be seen the Arabic equivalent of "Shell." On the two work tables in the foreground are the larger signs, involving deep draw, which are joined together on the site where they are to be erected back to back and illuminated from within. To the right of the tables can be seen another variety of sign which is erected without interior illumination. Fig. 12 shows the final stage before packing, where aluminium suspension brackets reinforcing are fitted around the periphery of the units and where also packing blocks are affixed in the case of the double signs, to prevent damage during transit.

The economic production of satisfactory units calls for considerable ingenuity of design and manipulation, as is fully evidenced by the photographs which illustrate this article. The importance should also be stressed of knowledge of the dimensional changes that take place in such deep-draw mouldings.

In Fig. 13 is shown the press and tool employed in the moulding of a refrigerator interior from semi-rigid p.v.c. sheet. This particular press is fitted with four small rams; here again the press is a self-contained unit. The press opened can be seen in Fig. 14; mounted on wooden blocks is the light-alloy tool. The lower tool is also of light alloy, supported by a steel framework and incorporating several movable plates to produce the ribs in the moulding. Clamping devices are also provided to effectively secure the sheet prior to and during the lowering of the punch. In Fig. 15 can be seen two moulded units, the upper one having been machined to the finished proportions and the lower one with the flanges still in place. This photograph demonstrates admirably the fidelity of reproduction that is possible by this technique.

Both the Shell mouldings and the refrigerator interior are excellent examples of the low-pressure moulding technique. The experience and results gained over the years by Thermo-Plastics, Ltd., has resulted in many other fabrications of a similar nature. Work currently in hand includes refrigerator door linings, and lighting fixtures, installed at Fenchurch Street Station during the recent renovations, and described briefly on page 88 of this issue.

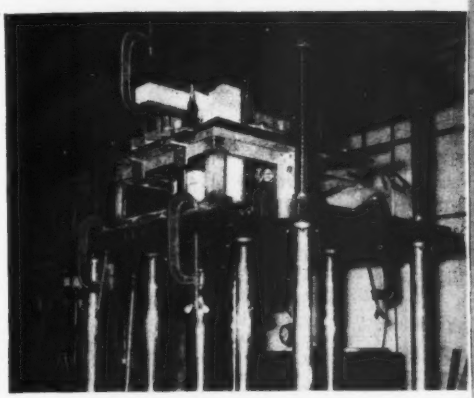


Fig. 13.—Assembly for refrigerator interior.

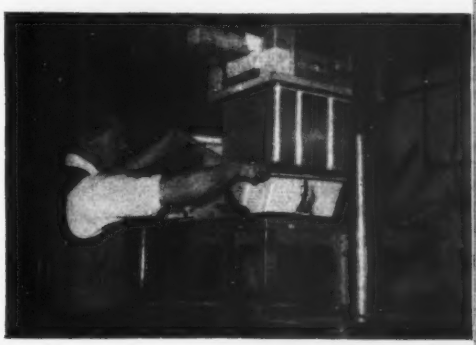


Fig. 14.—(Above) Moulding being removed from press. The upper tool, made from light alloy, can be seen.

Fig. 15.—(Right) Two moulded units, one trimmed to size, and the other, below, with flange still in place.

Progress in Plastics Sheet Welding

By E. C. STANLEY* and H. R. STILTON*

One of the most remarkable stories of rapid expansion in the plastics industry has been the growing production and use of plasticized polyvinyl chloride sheeting. Raincoats, handbags, wallets, toys and industrial components are produced from sheet ranging in thickness from .001" to .04". Whilst stitching is still widely employed to make up articles from p.v.c. sheet, by far the best method of fabrication is the technique of welding by means of heat generated within the plastic material by radio frequency electrical current. The following notes describe briefly some new applications of the welding technique and some trends in the design of welding equipment and welding tools.

SINCE the first appearance in Great Britain in 1945 of commercial articles manufactured from plasticized polyvinyl chloride sheeting, by the use of radio frequency welding, the estimated number of manufacturers using this type of equipment in the British Isles has risen to around 600, with the number of r.f. welding units over the 3,000 mark.

At present many companies employ just one or two small machines, perhaps giving no more than a 10-12-in. length of weld, to manufacture a part of an article such as the handle or lining of a handbag. Many users of r.f. welding equipments are small concerns employing a few semi-skilled female operators, and the general type of articles manufactured by them is normally allied to the fancy goods trade. Because of the limitations of their working capital, small production "runs" are favoured.

Other comparatively large trade welders employ 20 or more machines in the production of, among other things, garments and fancy goods. Some companies specialize in industrial applications such as packaging or car component manufacture and these frequently employ welding equipment specially designed and built for one specific purpose.

Applications of the Radio Frequency Welding Technique

The garment industry producing raincoats, boots and baby wear from sheets of .004-in. to .010-in. thick p.v.c. was one of the first and most important industries to use r.f. welding.

The r.f. welding technique has more recently been adopted by manufacturers of heavy-duty garments used by lifeboatmen and fishermen, as well as by the makers of industrial protective clothing. In the fancy goods industry, wallets, purses and similar items are now fully established and are produced from a wide variety of sheeting The large quantity of articles produced in this field have led to the development of tooling techniques giving maximum rates of output. The full range of cutting tools, jigs, and welding electrodes employed in the manufacture of a high-grade welded wallet can be seen illustrated below. Handbags are also made by r.f. welding, and an example was described in *Plastics*, September, 1952. With the production of thin calendered sheet, sometimes incorporating non-toxic plasticizers, welded p.v.c. is now competing with heat-sealed polythene for the packaging of fluids, chemicals and foodstuffs, as well as for protection from corrosion of engineering components. It is especially used when during a packaging process it is impossible to keep the area to be sealed in a dry condition, in which case polythene, being difficult to seal once it has been subjected to moisture, is an impracticable proposition.

The motorcar industry, which was one of the first to use welded p.v.c. for packaging, has been very quick to take advantage of the speed and efficiency of welding. Some examples include upholstery and covering of interior door panels; the welding into position of rear windows made from transparent flexible p.v.c. and the edging and joining of p.v.c.-coated felt flooring mats with extruded p.v.c. channelling.

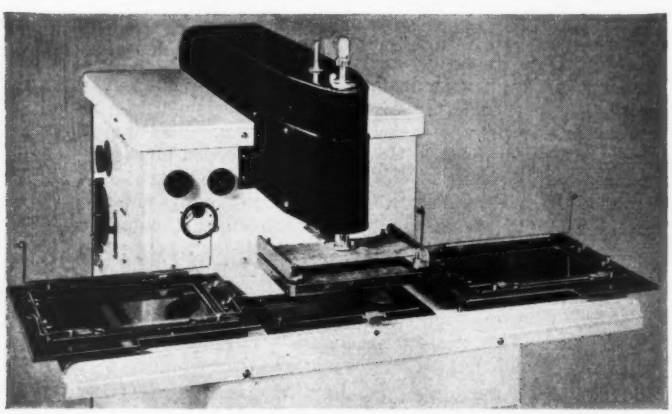
A large field for welding in the toy industry is in the production of inflated articles such as beach rings, balls, cushions, mattresses and boats. Laminated p.v.c. sheeting, frequently of two different colours is often employed to avoid the possibility of deflation due to tiny pin marks, which are sometimes present in single thicknesses of sheeting. Much ingenuity is required in the design of welding tools for these toys.

Large cinema screens are now produced from p.v.c. sheet joined together by welding. Another recent use is the waterproof insulation of electrical connection in electric blankets.

Choice of Machine

Many of these applications have been possible on standard welding equipment which has been available for several years,

* Radio Heaters Ltd., Wokingham, Berks.



Manufacture of a wallet: Patterns are cut by a range of cutting knives using a press such as a clicking press. Preliminary welding consists of embossing ornamental edge lines, welding on of stamp and ticket pockets, etc. and manufacture of small parts such as fastening loops and tabs (usually produced by multi-impression welding dies by the "tear-seal" system). The finished patterns are placed in a sliding loading frame and the finished article is welded in a single operation on a medium-sized welder. Approximately 1 kW. is required for the profile weld of a wallet such as the one illustrated. For high-speed production the loading frames for the final weld may be arranged so that one frame is clear of the machine for the loading and unloading operation, whilst the other frame is being welded. A shuttle-type loading system of this type is shown (right) fitted to a 1 kW. Radyne Model W.7. welder.

(Left) R.F. welding is used for most kinds of p.v.c. fancy goods. The illustration shows a selection of high-grade welded cases, purses, notebooks, etc.

(Right) Inflatable beach toys, lifebelts, cushions and medicine balls can be produced in either plain or laminated sheeting. Colourful designs can be silk-screen printed to enhance sales appeal.

but the greatly increased range of machine types being produced today necessitates careful choice of a machine to suit the anticipated range of products. For instance, an application which calls for a considerable length of weld can usually be performed either by using a powerful and expensive machine fitted with large electrodes, or by using a series of two or more smaller machines and breaking down the welding operation into a number of successive sections. There are many instances where a more favourable production rate with a greater reliability of product can be obtained by breaking down the job rather than by trying to use excessively large welding dies. The manufacture of welded raincoats is a good example of this. By employing relatively short electrodes for garment welding the handling and correct location of the material is greatly facilitated and although a larger number of actual welding cycles is necessary, nevertheless the throughput may be greater due to the easier manipulation of the sheeting when short electrodes are used. Undoubtedly the most versatile team of welders consists of several machines each fitted with relatively small or medium-sized jigs or electrodes, and a larger production line may include one or more machines capable of performing a fairly large weld in a single operation. There are, of course, a great number of tasks which can be done more effectively by the use of the larger type of press welder, but only where the technical considerations of the task favour the use of a considerable size or area of weld in a single shot, and where the size of the production run justifies the greater initial financial outlay.

Large-capacity Welders

Many specialized welding applications call for a press designed specifically for the work. The r.f. generator is often a separate unit and the feeding of the press platens or electrodes from the generator is in all cases an individually engineered job. Such applications may call for generator power outputs in excess of 10 kW.

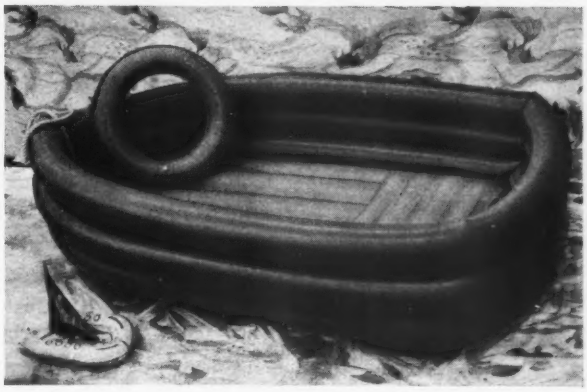
There are now available a standard range of press welders designed as self-contained units with power outputs of up to 6 kW. or more. On the larger presses the electrodes are usually operated pneumatically. Figure 11 shows a typical press welder of this type. The machine illustrated operates from a 3-phase supply and has a radio frequency output of 6 kW. at 20 megacycles per second. It is designed for work requiring a large amount of welding, within a platen area of approximately 6 sq. ft. This area is controlled by considerations of the electrical and mechanical requirements of the equipment, and is not necessarily limited by the power output of the generator. The maximum length or area of weld depends to a large extent on the type and thickness of sheeting employed. Under favourable circumstances, for instance, a machine of this type with an output of some 6 kW. may be capable of a profile weld length approaching 20 ft. in a single welding cycle, on the thicker grades of vinyl sheet.

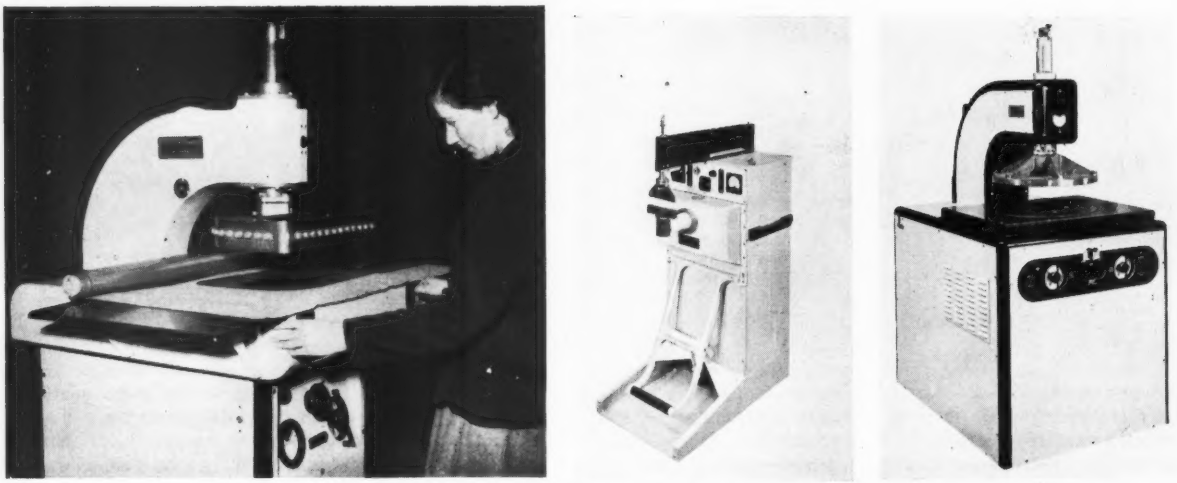
Tool Design

The rapid growth of the number and types of successful r.f. welding applications today has been made possible not only as a result of improvements in design of the welding machines themselves, but also as a result of the considerable amount of research and development work which has been put into the design of the electrodes and welder tools. It can be said that a machine is as good as the operator controlling it. It is even more true to say that a r.f. welding machine is only as good as the tools which are fitted to it. Using well-designed tools, and with attention to the correct setting of the welding power and welding time, a manufacturing process which requires mass-production methods can be made to a large extent fool-proof, giving a negligible percentage of rejects and producing a consistently high quality of great repetitive accuracy.

(Left) Typical heavy-duty protective wear in which the garments are first stitched and subsequently over-welded to seal the seams and render them completely waterproof.

(Right) A beach boat made in .01 in. laminated p.v.c. sheeting. Six air compartments fitted with separate inflating valves make it almost unsinkable. It can be packed into a small space when not in use and weighs only a few pounds. The size can be judged by the 22 in. diameter lifebelt.

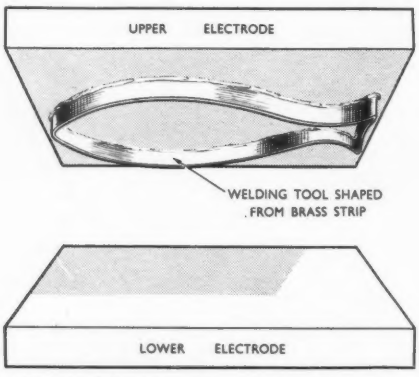




(Left) 3 kW. press welder Radyne model P.W. 22 being used for the welding of a transparent p.v.c. window to a tourer car hood made from p.v.c. spread-cloth. (Centre) One version of the versatile 600-watt Radyne model W.5 welder has the electrodes conveniently mounted for certain tasks in garment manufacture, or for welding tubular objects such as lampshades. Other versions of this machine include arrangements for flat plate welding, jig and frame welding and acetate box staying. A model with horizontal ram action is available for closing packages containing liquid. The machine is capable of fast welding cycles down to ¼-second on thinner grades of sheet, or with suitable dies up to a profile weld length of 24 in. on the thicker grades of sheeting. (Right) 6 kW. Radyne model P.W. 55 press welder capable of profile welds up to about 20 ft. The dies fitted to the machine weld a 22 in. diameter lifebelt in a single 2-second heating cycle. This operation requires a power setting of about 3 kW.

Provided the machine is fitted with suitable jigs, comparatively unskilled operators can readily be trained in the r.f. welding process. This may be an important factor when deciding whether a p.v.c. fabrication is to be produced by welding or by stitching, which is, by comparison, a skilled operation.

Many users of plastics sheet welders are already aware of the full capabilities of their equipments and fully appreciate the fact that the quality of their products depends on the quality of the welding electrodes and jigs which they employ. There are, however, still a number of welding concerns to whom the sheer necessity for maximum throughput outweighs considerations of quality in the product. Undoubtedly this state of affairs will be rectified as the continuing pressure of competition demands an all-round improvement in the standard of the finished goods. Unless the user of a welder has adequate facilities for the manufacture of his own electrodes, and in any case until he has acquired the necessary knowledge and experience of the detailed design of such tools, it is always the best policy to use tools designed and made by the producers of the welding equipment. Relative to the cost of most conventional press tools, welder electrodes are not expensive and in most cases pay for their own cost in a very short time. It must be borne in mind that ultimately the best price will be obtained for goods of the best standard of manufacture and finish. It therefore always pays to use high-grade tools and fittings wherever this is practicable.



Method of shaping simple tools from brass strip.

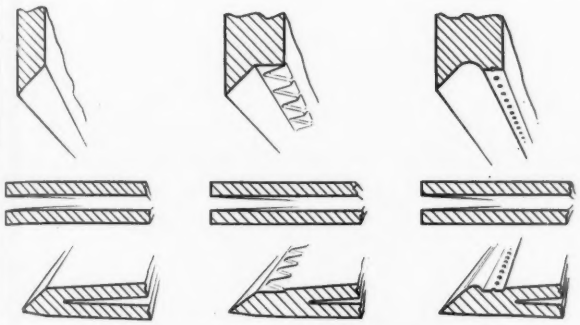
For the purpose of making samples, "knock-ups" of new designs, or small-run production work, it is of course possible to employ comparatively rough tools which the welder can easily make up himself. For instance, a simple system of tooling consists of a pair of electrodes, each a plate with the inner surfaces perfectly flat and parallel to each other. The actual electrode which gives the required shape of weld consists of a strip of metal bent or formed to shape. This can be fastened to the top plate by means of ordinary soft solder; see diagram. The welding edge is finally made smooth and is trimmed by hand-lapping until the desired result is achieved on test. The strip normally used is brass or copper 1 in. wide and of the necessary thickness to produce the desired width of weld.

Provided that the thickness of the strip is not greater than about $\frac{3}{16}$ in., very simple tools such as a small vice, files, hammer, etc., are all that are required. If a chamfered welding edge is given to the strip electrode, the articles can be made by the "tear-seal" method of welding, thus reducing or even in some cases eliminating the necessity for pre-cutting of the patterns. The p.v.c. material need not be accurately cut to shape prior to the welding operations.

Tear-seal Welding

The "tear-seal" method of welding is now widely used wherever the product can be satisfactorily made by this process. Basically the difference between tear-seal and other welding tools is simply that the "tear-seal" electrode is encouraged to sink sufficiently deeply into the material to allow the surplus to be torn or stripped away after the weld. It is usually necessary to cover the lower electrode or plate by means of a layer of suitable insulating material such as a thin sheet of resin-bonded paper laminate or suitable varnished fabric, which acts both as a cutting board and also serves to prevent the electrodes from touching or short-circuiting together after the top electrode has sunk through the work.

Many different types of edge finish can be produced by incorporating suitably ornamented ledges or beads running along the inside of the cutting or "tear-seal" part of the



Tear-seal welding : The diagram shows how shaped welding electrodes (top) are used to join two sheets of p.v.c. (centre) to give various edges on the final weld (bottom). From left to right : Plain, deckled ledge, bead with small raised dots.

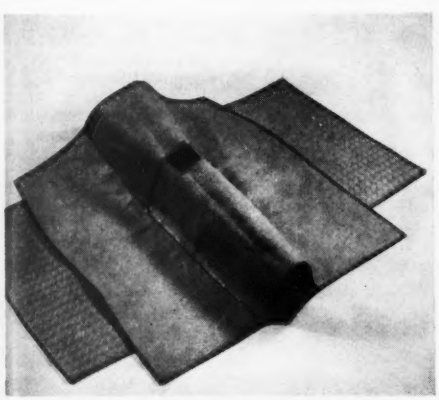
welding electrode. The chief advantage of the " tear-seal " welding method is that by virtue of the fact that the patterns are cut out at the same time as they are being welded, in many cases a pre-cutting operation is eliminated. There is thus not only a saving by eliminating the cutting operation itself, but also some saving is effected by the reduction in the number of pattern knives required. It does not follow that all cutting operations are eliminated, since in many cases an article will require nearly as many pre-cut patterns if the welding is done by the " tear-seal " system as would be the case if the same article was made by frame welding. The accuracy with which the patterns are pre-cut, however, is generally not so critical, and the pattern knives are therefore in many cases simpler in design. The simplest type of " tear-seal " electrode is made by chamfering the edge of the welding electrode to a blunt knife-edge. This will give a very narrow but strong weld without any decorative edge. Other types of " tear-seal " electrode can be made to produce decorative edge finishes such as imitation stitching, half-round bead or a plain-edge weld of appreciable width. This type of decoration is produced by using an electrode which is broadly speaking similar to a plain welding tool, but with the addition of a cutting edge built round the outside of the tool itself. In some cases the composite edge finish is carved from the solid brass or copper block by means of a die sinker or other suitable engraving machine. In other cases the tool is to all intents and purposes similar to an ordinary welding electrode built up from strip metal fastened round the edge of a metal backing plate or former and with the addition of a detachable blade which in turn is fastened to the outside of the welding tool proper. In such cases phosphor-bronze strip of about 20 swg. is frequently employed. A composite tool of this type has the advantage that the cutting edge can be readily replaced if damaged, and moreover the step between the edge of the cutting knife and the face of the welding tool inside it can be adjusted to suit different total thicknesses of sheeting composing the article to be welded. In most cases, however, the tool must be correctly designed to suit the total thickness of material to be welded within a fairly close tolerance. Usually when designing the tool the total thickness of sheeting must be known to within about plus or minus 0.002 in. on a total thickness of 0.040-in. " Tear-seal " type electrodes are nearly always used in conjunction with a flat plate type lower electrode, so that only a single top " tear-seal " electrode is required and not a pair of dies, as is necessary in other types of tooling.

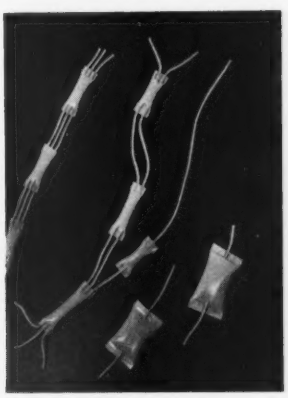
Three-dimensional Welding

A recent development is the increasing use of special electrodes and die-sets for the manufacture of three-dimensional articles such as purses, small camera cases and the like. Usually there are at least three distinct operations involved. First the patterns are cut, in some cases by press knife or in others by the use of " tear-seal " electrodes which serve the dual purpose of cutting out the patterns and if required welding a layer of lining material to the main pattern pieces. The second operation is the " forming " of certain of the patterns which will be used for the side gusset or body of the case. In the simplest type of article a rectangular pattern piece is formed by the use of special electrodes, broadly speaking, similar to a miniature brake-press tool so that a channel section pattern is produced. This is finally fitted round a forming block, which forms part of the pair of dies used for the main assembly weld. The front and back panels are then welded to the side or gusset pattern, and finally the forming block or bolster is removed from the finished article. If the forming block is fitted inside the article, Fig. 15, a smooth corner finish results similar to a box shape.

The Future of Plastic Sheet Welding

New developments are continually taking place, and it is impossible in a short article such as this to do more than touch on a few general aspects of this comparatively new technique. However, r.f. welding has become an established industrial process, and the immediate future is likely to prove a period of consolidation and improvement in materials and methods.





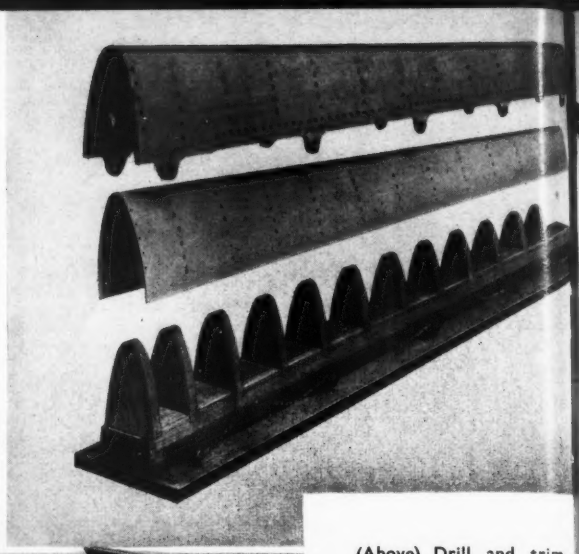
(Left) Mats fabricated by r.f. welding from p.v.c.-coated " Hardura " felt. Suitable p.v.c. extrusion is used for the joints. The top mat, welded together from three pieces of coated felt, is " tailored " to fit the floor of a motor car. (Centre) A specialized welding application : Electrical joints or components inserted in cable leads are protected by welding a p.v.c. sheath over the joint to render it completely watertight. (Right) Radyne model W5/B welder fitted with dies for the assembly weld of a round three-dimensional purse. The main patterns are first produced by the " tear-seal " system. The pattern which will form the sides of the purse is produced by a special forming operation. Finally the patterns are loaded together in the frame shown using an internal bolster piece, which is subsequently removed from the finished article.

PLASTICS
IN THE SERVICE OF MAN

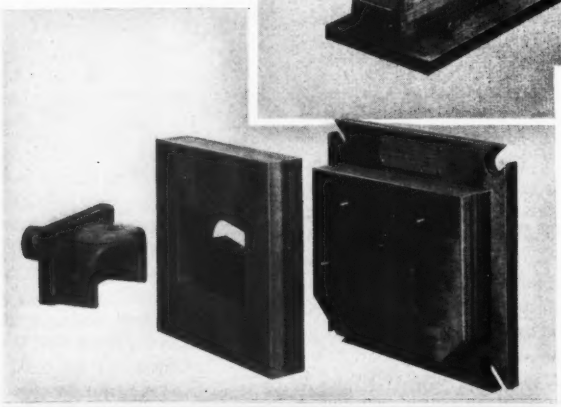
A pictorial review of high-quality units moulded or otherwise fabricated in Great Britain . . .

46. Tools and Engineering Components—2

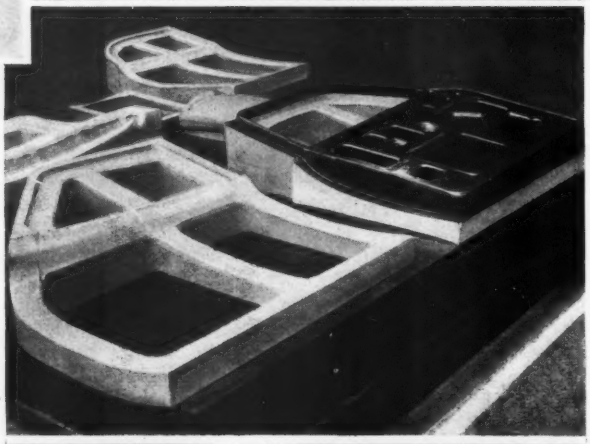
A list of names and addresses mentioned in this review appears on page 90



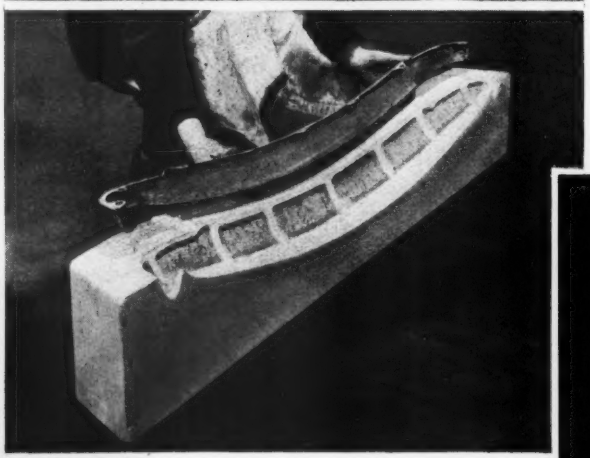
(Above) Drill and trim shroud made by Hordern-Richmond Ltd., comprises a resin-bonded glass fabric laminate shroud (top) with support frame of Hy-du-lignum resin-bonded densified wood. The trimmed drilled component is shown (centre). (Photo by courtesy of Motor Panels (Coventry) Ltd.)



(Above and above right) Marking jig made by Hordern-Richmond Ltd., from polyester resin-bonded glass fabric laminate, shown with the untrimmed pressing from which it was produced. The set of mechanical press tools for the same component, made from Hy-du-lignum densified wood laminate, are shown in the adjacent illustration. (Photos by courtesy of Morris Motors (Radiators) Ltd.)



(Left) Phenolic resin castings made from resins supplied by Catalin Ltd., are used by Nuffield Metal Products Ltd., for inspection fixtures for car door panels and door assemblies.



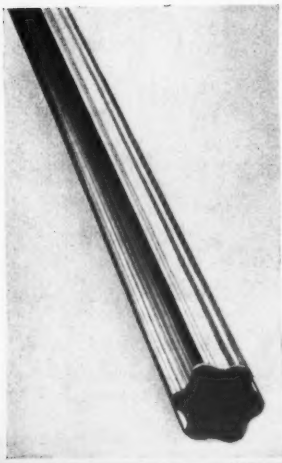
(Left) Phenolic casting, from resin supplied by Catalin Ltd., is made by Nuffield Metal Products Ltd., as inspection fixture for car component.

(Below) Phenolic castings, made from resin supplied by Catalin Ltd., are used by Nuffield Metal Products Ltd., as assembly fixtures in the manufacture of car bodies.

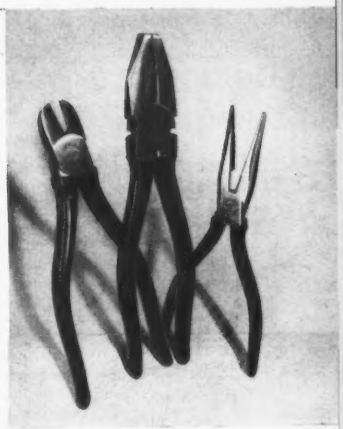
(Right) Duplicate of original mahogany model of car radiator shell is reproduced in cast phenolic resins made by Catalin Ltd. Nuffield Metal Products Ltd., use cast resin models because they are more stable and wear-resistant than wood.

(Above) The transparent handle for this multi-purpose screwdriver manufactured by Stanley Works (Great Britain), Ltd., is moulded by Lacrinoid Products, Ltd., from Tenite II cellulose acetate butyrate supplied by Kodak, Ltd. The handle acts as a container for interchangeable tool heads.

(Below) Clear amber Tenite cellulose acetate butyrate rod extruded by Melwood Thermoplastics, Ltd., can easily be machined to make strong and attractive screwdriver handles.

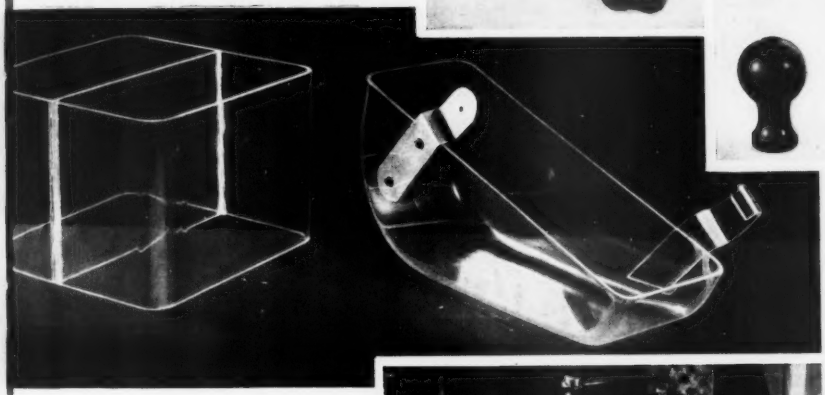


(Left) This small ball-bearing housing made from Tufnol synthetic resin-bonded laminate demonstrates the accuracy with which this material can be machined. Made by Tufnol, Ltd., it is hard wearing, light in weight and silent in movement.



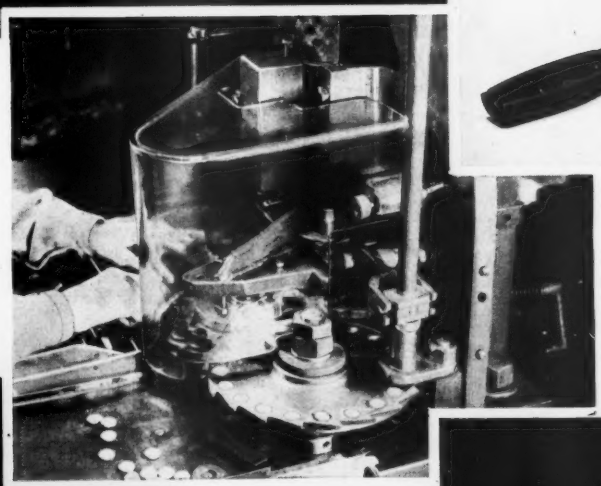
(Right) Handles of these electricians' pliers made by Elliot-Lucas, Ltd., are insulated with Vietum shrunk-on vinyl covers supplied by Lacrinoid Products, Ltd.; they are tested to withstand 10,000 volts.

(Below) Machine components fabricated from Perspex acrylic sheet by Ashdowns, Ltd., include a feed spout (left) and a machine guard (right).

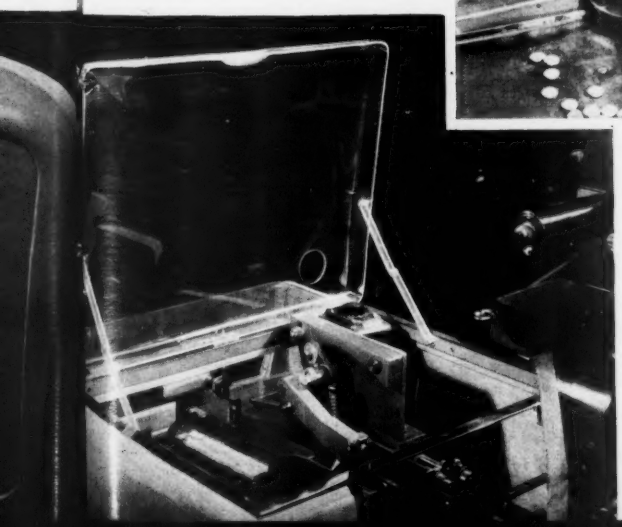


(Left) Handle and knob for a plane, manufactured by Anglo-Scottish Tool Co., Ltd., are produced from phenolic material by Kent Mouldings.

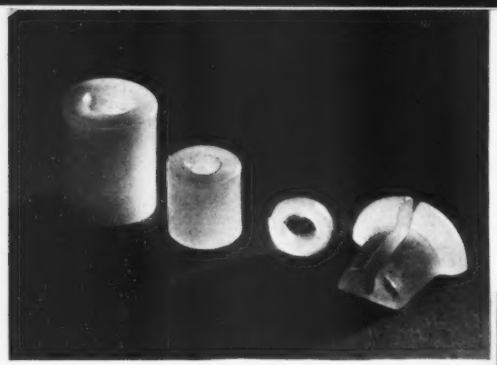
(Right and below) The toughness, transparency and ease of shaping of Perspex acrylic sheet make it an ideal material for machine guards where visibility is important. Examples include the guard for an air cushion wad assembly machine at I.C.I., Kynoch Works (right), and the cover guard for a packaging machine manufactured by Molins, Ltd. (below).



(Above) Brace handles and knob are moulded in phenolic material by Kent Mouldings for Anglo-Scottish Tool Co., Ltd.; the two halves in which the handle is moulded are seen in the foreground.

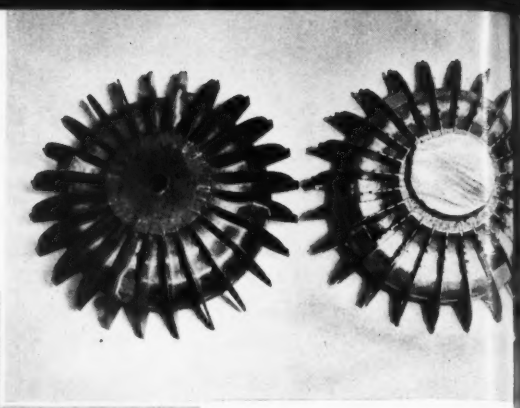


(Right) The Kimball midget ticket marking machine made by R. B. Production and Engineering Co., Ltd., and distributed by A. Kimball Co., Ltd., employs handle, ticket guide and feed compensation roller fabricated by Lacrinoid Products, Ltd., in red cast resin.



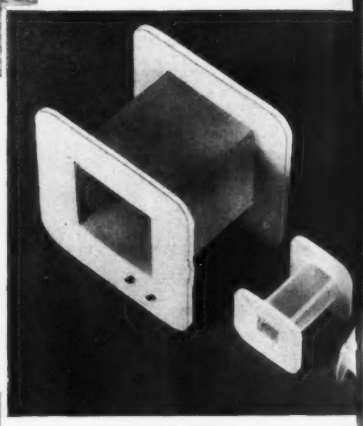
(Above) Bearings, bushings and other engineering components are injection moulded from nylon by Fraser and Glass Ltd.

(Below) Protective flexible gaiter for a ball joint is manufactured by Creators Ltd., from p.v.c. by the paste dipping process.



(Above) Pattern for sand casting manufactured from Tufnol laminates (left); the finished casting is seen on the right. Such patterns are easily machined and are stable, light, and do not corrode. (Photo: Tufnol, Ltd.).

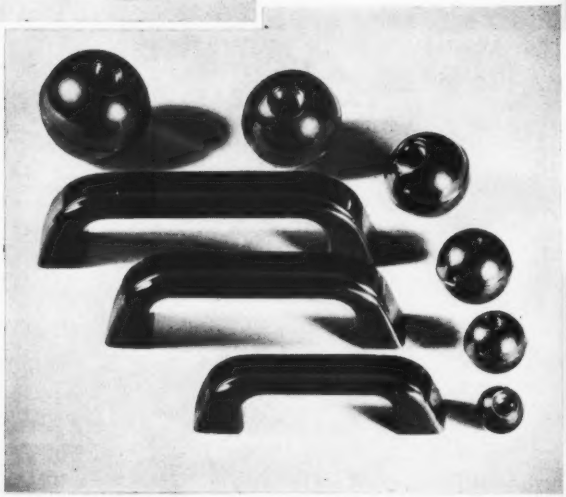
PLASTICS
MARCH 1954



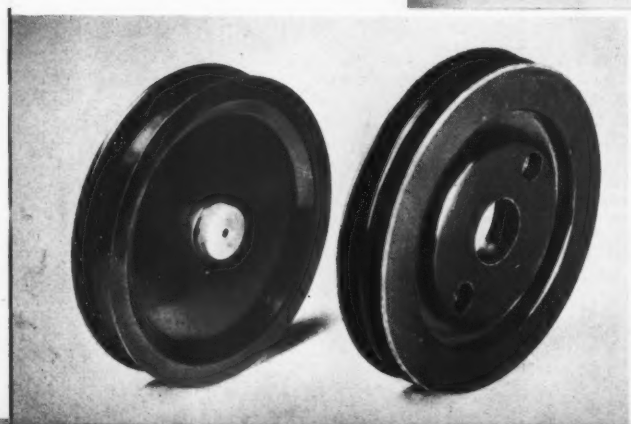
(Above) Lever handles and knobs for engineering equipment are moulded by Frederick W. Evans Ltd.

(Right) Standard spherical threaded knobs from $\frac{3}{4}$ in. to 2 in. diameter and standard grip handles for portable tools and instruments are moulded by Litholite Insulators and St. Albans Mouldings Ltd., from black Bakelite X20/5 phenolic material.

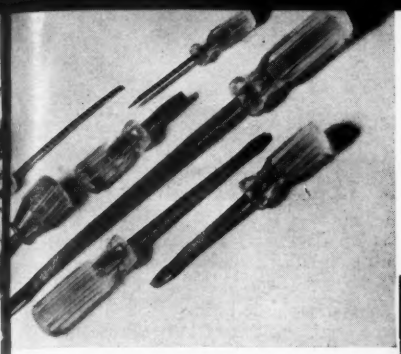
(Below) Pulley wheels with metal inserts are moulded in phenolic material by Frederick W. Evans Ltd.



(Above) Injection moulded nylon coil former bobbins made by Fraser and Glass Ltd., are strong, light in weight and have excellent electrical properties.



(Right) The base, shaft, motor housing and other main components of the small Waco drilling machine are moulded in black phenolic material by the manufacturers, Walter Machines Ltd. A shaped Perspex guard protects the drive. Only minor changes have been made since the machine was described in *Plastics* November 1948, page 568.

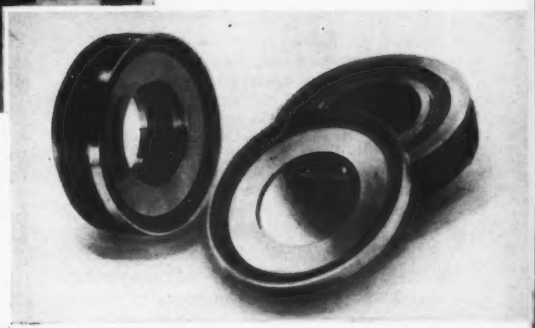


(Left) Screwdrivers manufactured by Gordon Tools Ltd., are fitted with clear yellow handles injection moulded by Lacrinoid Products Ltd., from Tenite II cellulose acetate butyrate supplied by Kodak Ltd.

(Right) Two parts of the outer casing of a hydraulic textile loom buffer manufactured by Mellor Bromley and Co. Ltd., are bonded together by Araldite epoxy resin adhesive made by Aero Research Ltd. The bond has successfully withstood several years of service.

(Below) Tungsten carbide cutters are bonded to mild steel mounts by Redux synthetic resin metal-to-metal adhesive manufactured by Aero Research Ltd.

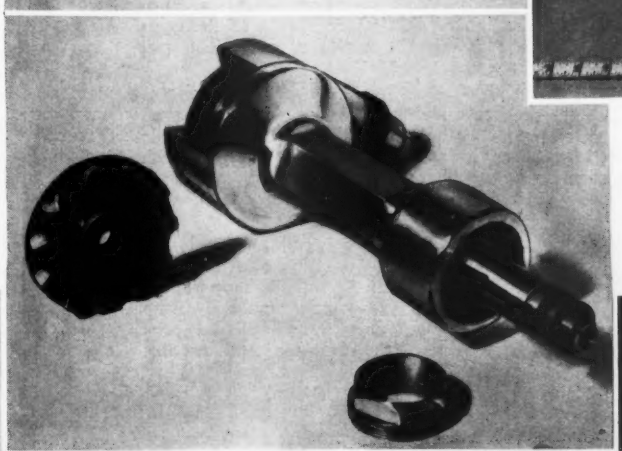
(Below) Gland packings to withstand chemical attack over a wide temperature range are produced by Crane Packings Ltd., from Fluon polytetrafluoroethylene by moulding or by braiding from tape. The inertness of the material makes it particularly useful in the chemical and electrical industries.



(Above) Armourvin wire - reinforced p.v.c. tubing, extruded by Creators Ltd., conveys compressed air to operate Lorant air grinders.

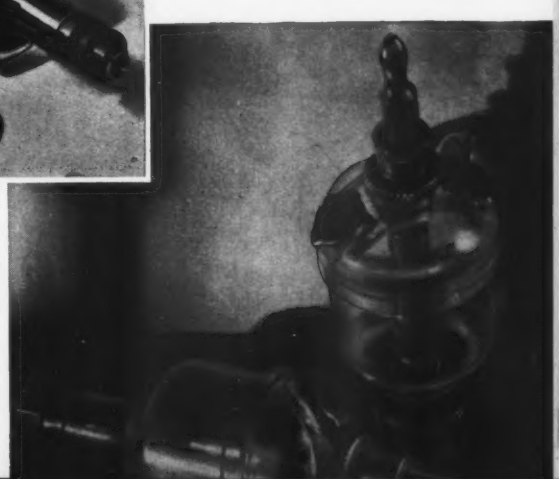
(Below) 2½-in. nylon lock nut made by Simmonds Aerocessories Ltd., employs nylon inserts injection moulded by Plastic Engineers Ltd. Two insert rings (left) are seen attached to the moulding sprue. (Photo : I.C.I.)

(Right) Goggles made by Lincoln Electric Ltd., for use by inspectors, foremen, etc., who frequently walk through welding shops, to protect their eyes from occasional flashes from arc welding operations. The frames are moulded in phenolic material by W. W. Ball and Sons Ltd.



(Below) To demonstrate the high strength of Araldite epoxy resin adhesive, manufactured by Aero Research Ltd., steel bicycle forks were tested to destruction. Fracture has occurred in the metal, but the resin-bonded joint remains undamaged.

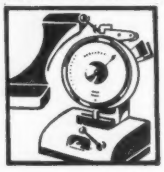
(Below) Transparent oil filler caps are moulded by Punfield and Barstow (Mouldings) Ltd., from clear Diakon acrylic material supplied by I.C.I. Ltd.



(Above) Ajax air turbine hand grinder, with rotor housing cut away to show the rotor machined from Tufnol phenolic resin-bonded laminate, and cover removed to show one of the Tufnol ball race cages. The sectioned rotor (left) shows the intricate machining. (*Plastics*, 1951/July/202.)

World's Industry Employs Plastics

MATERIALS and TESTING



Elastic constants of laminates. — R. U. Witt and coll. give theoretical basis and describe apparatus for determining the anisotropic elastic constants by measuring the deflection of a thin plate. The elastic moduli for three different laminates have been determined.
(*A.S.T.M. Bulletin*, 1953/Dec./53.)

Crazing of polymethyl methacrylate.—In this discussion on stress and strain at the onset of crazing attention is drawn to different methods, other than those discussed by the authors.
(*A.S.T.M. Bulletin*, 1953/Dec./61.)

Phenolic glass laminates for elevated temperatures.—Recent developments in heat-resisting resins for reinforced plastics have made them useful for the temperature range from 300 to 500 degrees F.
(*Materials and Methods*, 1953/Nov./87.)

Graphic representation of temperature dependence.—A. V. Blom suggests plotting graphically the change of physical properties with temperature, thus differentiating between solid, relaxation state A, visco-elastic condition, melting interval B, fluid condition or decomposition of plastomers. This is explained with a number of examples.
(*Kunststoffe*, 1953/Aug./294.)

Elastomers for low temperatures.—Aircraft and military equipment for operating at extremely low temperatures, sometimes below −60 degrees F. have led to the successful development of natural and synthetic rubber compounds for these requirements. of which a survey is given.
(*Materials and Methods*, 1953/Nov./114.)

Melamine-formaldehyde moulded plastics.—General data on physical, mechanical and electrical properties of a number of commercial types are given in a data sheet.
(*Materials and Methods*, 1953/Nov./139.)

Silicone resin foam has proved useful as a high temperature insulator; it can even be heated over a Bunsen burner.
(*Materials and Methods*, 1953/Nov./96.)

Silicone elastomers.—The development of cross-linked silicone polymers with rubber-like properties has resulted in a valuable new range of materials with unique electrical and mechanical properties at high and low temperatures.
(*Research*, 1953/Dec./458.)

Heat-stable vinyl for injection moulding.—Monsanto Chemical Co. have developed free-flowing powders which can be dry-blended by the moulder. Further, a high heat stability is claimed. Blending is performed at a relatively low temperature and the compounds reach the injection press at a minimum of heat history, reducing tendency to decomposition.
(*Materials and Methods*, 1954/Oct./160.)

New material for chemical apparatus.—Bascodur is a new thermo-setting resin consisting of a resinous binder derived from modified phenolic hardening condensation products and high percentage of fillers, such as graphite, coal, coke, etc.
(*Kunststoffe*, 1953/Oct./376.)

INDUSTRIAL APPLICATIONS

A pressure-sensitive tape made of fluorocarbon tape may find wide industrial use, particularly in electrical applications. The adhesive is a silicone type and with it the tape can be fixed to metals. The silicone adhesive remains strong and tacky from 300°F. to below −65° F.
(*Materials and Methods*, 1953/Dec./103.)

Plastics in the foundry.—G. Genin gives a thorough survey on the application of plastics in the foundry describing in particular the J. Croning process in which the property of phenol formaldehyde resins not fully condensed is used. The resin mixed with sand is hardened under heat and thus forms a strong mould.
(*Revue General de Mécanique*, 1953/Sep./311.)

Shell moulding equipment.—British Cast Iron Research Association, Alvechurch, Birmingham, have devised a pneumatic clamp for holding shell moulds for casting. Two sets of sliding pins are fitted as plungers through the back of two facing hollow chambers. The pins are pressed evenly and firmly against the backs of the facing mould halves by means of compressed air.
(*Machinery Lloyd*, 1953/Nov. 14/95.)

Oil pipeline.—First cross-country cellulose acetate butyrate pipeline has been completed in the Willston Oil basin, U.S.A. The inner diameter is 3 in. and the wall thickness $\frac{1}{8}$ in.; maximum pressure to be sustained is 90 lb./sq. in. at 60° F. temperature. There is considerable saving in weight: a 20-ft. section of plastic pipe weighs 13 lb., compared with 153 lb. for an equivalent steel section.
(*Product Engineering*, 1953/Dec./280.)

Large plastic mouldings.—J. B. Campbell surveys the possibilities at present available for producing large plastics housings, such as washing machine agitators, radio and TV cabinets. New uses may be air conditioners, office machines and furniture.
(*Materials and Methods*, 1953/Dec./9.)

Phenolic laminates in van construction.—Description of 25-cwt. mobile shop and of a 5-ton meat van body, built largely from paper base phenolic plastics, believed to be first structural use of this material for this purpose.
(*Motor Body*, 1953/Oct./10.)

Neoprene-lined barrel tumbler.—White-Roth Machine Corp. produce a new machine of welded steel construction, with door made of aluminium. A neoprene lining is fixed extending barrel life and assuring quiet operation.
(*Materials and Methods*, 1953/Oct./204.)

Nylon as engineering material.—E. M. Elliott in a paper to the Institution of Production Engineers gave general information on nylon and its engineering uses.
(*Machinery (Lond.)*, 1953/Nov. 20/1003.)

A thermoplastic coating is used to determine the blank size of intricate sheet-metal parts. A thermoplastic material Miccrosol of Michigan Chrome and Chemical Co. is used. Blank sizes can now be determined without long hours of computation.
(*Machine Tool and Blue Book*, 1953/Dec./153.)

PROCESSES : MACHINERY

Production machining of nylon.—Methods and tool angles for machining nylon rod stock are given. The material is extremely free-cutting, permitting heavy feeds with cutting speeds of 500-700 ft./min.
(*Machinery* (New York), 1953/Dec./163.)

Vacuum - forming extruded plastic.—D. Woodruff discusses how to reduce costs by the use of this process. Large sheets of high quality plastic are produced in low cost single dies. There is virtually no limitation as to size or contour.
(*American Machinist*, 1953/Sep./14/153.)

Liquid heating of plastics machinery.—Discusses the correct design of liquid heating and cooling systems. Through the advantages offered by these systems other media are being quickly displaced.
(*Mechanical Engineering*, 1953/Dec./957.)

MISCELLANEOUS USES

Moulded boxes from stock. — The availability of a range of moulded plastics containers in standard sizes and shapes makes it possible to use such containers for many products for which specially moulded boxes would be hopelessly uneconomic.
(*Packaging*, 1954/Feb./48.)

Synthetic fishing floats.—A. V. Brandt reports on tests with floats for nets made from expanded polystyrene and p.v.c. More progress in this field is expected.
(*Kunststoffe*, 1953/Aug./302.)

Plastics floor coverings.—P. Kraenzlein gives a survey showing how the older linseed oil floor coverings which are now more and more replaced by plastics. The various raw materials are discussed and the manufacturing techniques dealt with.
(*Kunststoffe*, 1953/Aug./305.)

Glass fibre laminations in a fishing cruiser.—An American firm covered the hull of a 31-ft. fishing cruiser with three laminations of their glass cloth and resin and also replaced the canvas on the deck and cabin top of a 32-ft. cruiser with a laminate consisting of one layer of cloth and three of resin.
(*Materials and Methods*, 1953/Oct./133.)

Viewers for 3-D Films

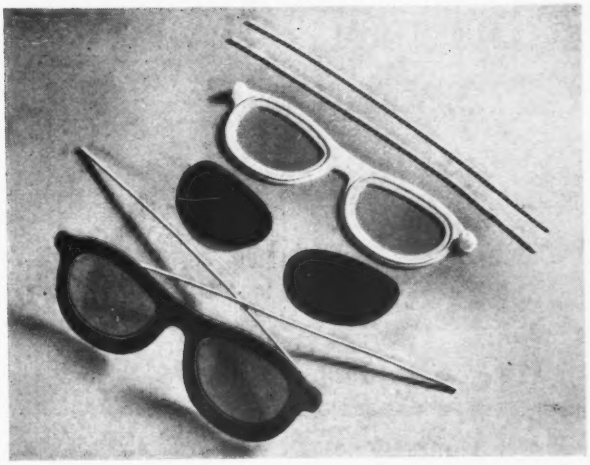
STEREOSCOPIC or three-dimensional films have been known for many years. However, the popularity of the Telekinema performances of 3-D films at the Festival of Britain in 1951, together with technical improvements in systems of film making and projection, have led to a steadily increasing output of three-dimensional films from Hollywood. All systems of showing such films require the viewer to wear special spectacles to obtain a true stereoscopic effect.

The difference between the human eyes and an ordinary film camera is that, whereas the camera only takes one view of any scene the eyes, as used in normal vision, see slightly different images of the same scene which are combined in the brain to give the impression of depth. In film making the stereoscopic system gives the illusion of depth and controls apparent vision of the image in space by presenting the two individual eyes of the viewer with two separate and slightly different images, corresponding to the two different impressions received by the eyes in viewing the actual scene.

To obtain such a film a compound camera is employed having two lenses separated by the approximate distance between two human eyes. Thus two parallel films are obtained, each representing the view as seen by one eye. The technical problem then arises of projecting the two parallel films in such a way that the "left eye" picture is presented only to the left eye of the viewer and the "right eye" picture only to the right eye of the viewer.

One of the methods devised to solve this problem makes use of the phenomenon of polarization, i.e., the property of certain crystals to absorb light waves so that only waves vibrating in one direction pass through the polarizing filter.

For 3-D viewing it is possible to pass light from each of the two film projectors through a polarizing filter, projecting both images on to the same screen to give one "double image." If the viewer then wears polarizing spectacles orientated in opposing directions for each eye, only light-waves of the desired nature will be received by each eye. To put this system into practice it is necessary to provide each viewer with a pair of spectacles fitted with polarizing filters.



A complete pair of polarizing viewers, shown with the five individual components — lenses, side-pieces and frame.

Early spectacles of this type were expensive and remained the property of the cinema exhibitor. It was, of course, necessary to safeguard against disease by sterilizing after use. For this purpose it was not possible to use boiling water nor did most chemical sterilizing methods prove effective without damaging the viewers. If means could be found to make polarizing spectacles sufficiently cheaply, these could be given away, or sold at very low cost to viewers. One type of "throw-away" viewer was developed in the U.S.A. by the Pola-Lite Company, a division of the Commerce International Company of New York. Recently an agreement was made between Pola-Lite Company and True-View, Ltd., 36 Atholl Street, Douglas, Isle of Man, for the manufacture of Pola-Lite spectacles in Great Britain. The task of manufacturing the frames and assembling the viewers was undertaken by Halex

Wire side-pieces are dipped in solvent adhesive and inserted in locating bosses on the frame.

Lenses are bonded to the frame by this pneumatically-operated crimping/heat-sealing tool.

(Above) A conveyor belt takes frames to be fitted with lenses, and subsequent inspection.

(Right) Part of the assembly line showing the fitting of lenses.

Division of British Xylonite Co., Ltd. The completed spectacles are distributed throughout the world, except in U.S.A. and Canada, by G. B. Kalee, Ltd., Mortimer House, Mortimer Street, London, W.1.

In the Pola-Lite spectacles plastics materials, lending themselves to fast mass-production methods, are used in three forms—sheeting, mouldings and extrusions. The lenses consist of a layer of polarizing crystals embedded in a gelatinous medium, which is laminated on one side by a thin film of optically clear transparent cellulose acetate film. The other side is protected by an applied coating of transparent lacquer. The frames are injection-moulded from polystyrene and the side pieces, or temple pieces, are of wire with an extruded coating of polystyrene. The all-plastic construction permits assembly in only two stages—cementing the side pieces to the frame by solvent adhesive and bonding the lenses to the frame by heat sealing.

We visited Halex, Ltd., to see the setting into action of an assembly line which, when finally completed, is intended to produce up to one million pairs of viewers per week. So far only one line employing a team of 13 girls is in action producing between 80,000 and 100,000 pairs per week.

Halex receive the polarizing lenses pre-cut and ready to fit into frames. The frames are injection moulded on a multi-impression tool; the design of the frame is simple, being flat with the exception of two bosses for locating the side pieces and locating flanges for the lenses. The side pieces are simple metal wires with an extruded coating of polystyrene. In the first stage of assembly the wire, which is received in the assembly shop in cut lengths of the desired size, is dipped at one end in a wax composition to protect one bare end of metal. To assemble the side pieces the other end of the wire is dipped into a polystyrene solvent adhesive solution and inserted in the locating bosses of the frames. This provides a bond so strong that when the adhesive has set it is practically impossible to pull the side pieces out of the frames. The assembled frames are stacked in batches of 50 on cardboard trays. Completed batches are placed on a conveyor belt to travel to the final assembly stage, i.e., the fitting of the lenses. A small pneumatically-operated heat-sealing machine has been designed to perform this operation. Frames are located in a fixture on the lower platen of the machine, the pre-cut film lenses are placed in position, being located by the raised flanges moulded on the frame. The upper platen is then lowered, pressing the crimping/heat-sealing tool round the edges of the film lenses and permanently bonding these to the frames. The pneumatic press is operated by depressing two buttons simultaneously; this provides a simple safety device preventing the operator from injuring her hands in the tool.

The completed viewers are inspected against a polarized light.

The viewers are now complete but must be inspected to ensure not only that they are free from normal production faults but that the polarizing properties are correct. For this purpose the viewers are inspected against a light source which has been passed through a polarizing filter. Correctly-assembled viewers will then appear with one obscured and transparent lens.

Since after optical efficiency low cost is the predominant consideration, the viewers are not packed individually but are placed in boxes in batches of five thousand ready for despatch to cinema exhibitors throughout the world.

(Above) Fig. 1.—The Lockheed P2V "Neptune" with 17-ft. long fuselage extension. (Right) Fig. 2.—An inspector checks the interior of the "tail."

Reinforced Plastics Fuselages For U.S. Aircraft

By WILLIAM E. BRAHAM*

The following article traces the stages in preparing for the production of a six-part reinforced plastics fuselage extension, housing submarine detection equipment in a U.S. Navy Lockheed P2V Neptune aircraft. This article is appearing in "Aviation Week".

THE recognition of reinforced plastics as a sound aircraft structural material makes itself evident again in the "stinger tail" of the U.S. Navy Neptune (P2V) long-range patrol aeroplane. The addition of this reinforced plastics fuselage structure to the family of reinforced plastics parts—radomes and fin tips—makes the Neptune a most effective and efficient submarine hunter. It houses new weapons that can seek out and localize submarines beneath the seas.

Here again, the proven properties and characteristics of reinforced plastics help to combat the ever-increasing complexities of aircraft design and performance. Here again, it has been proved that reinforced plastics structures can be produced with one-fifth the engineering man-hours in one-seventh the factory floor-space, with one-sixth the production manpower, and with tools and equipment costs at 27% of that required to produce the equivalent metal aeroplane structure.

After a rigorous study of many materials and types of structures, Lockheed engineers chose a monocoque honeycomb sandwich design made of glass cloth impregnated with Bakelite polyester resins, utilizing low-pressure moulding techniques. (Fig. 2.) This structure has no stringers, rings, or bulkheads, other than those required at joints. (Fig. 3.) With Zenith Plastics Company and Lockheed Aircraft Corporation working closely together, Lockheed quickly produced drawings, Zenith built a test unit, and in a few short months a test to destruction was attempted. The results of the test were very good, in that there were no signs of failure or local deformations—commonly encountered in typical metal aeroplane structures—up to almost 300% of the ultimate load. The test was never completed, because the test rig could not apply enough load to destroy the test unit.

Confident that the test results would be satisfactory, Zenith Plastics Company began the fabrication of permanent production tools immediately after the test unit was completed. This is the story of Zenith's production programme—from the time tool designing was begun in Zenith's engineering department to the present—a production of at least two complete "stinger tails" per day.

Supplied with advance copies of Lockheed's production drawings, loft lines, and templates, Zenith engineers began the tool design and production planning required to produce at least two complete fuselage structures per day. Six large moulds were required to produce the five basic sections of the structure. (Five sections were required to meet the requirement that the structure be readily disassembled, and that it fit into a small space for aerial shipment.) (See Fig. 3.) To produce economically accurate sections within the required close tolerances for interchangeable parts, it was decided to use metal-sprayed moulds.

Two assembly fixtures were designed concurrently with the moulds. These fixtures also served as drill jigs for mating holes in the five sections. All the tool designs were completed in a time estimated to be equivalent to 12% of the time required to produce a suitable metallic fuselage structure.

Production planning and the procurement of materials was carried out swiftly according to present-day aircraft standards. The time required for this phase of the programme amounted to about 20% of that normally consumed in producing an equivalent metal fuselage semi-monocoque structure because of the ultra-simplicity of the reinforced plastics structure—few rivets, virtually no stringers, frames, bulkheads, and fittings.

The first tools built were mock-ups, or full-size patterns, of the outside mould lines of each section of the fuselage structure. Each mock-up consisted of metal templates mounted on steel frames that were carefully constructed to ensure that close tolerances would be maintained. Each entire mock-up structure was firmly attached to a heavy steel base plate and rough reinforced plaster was used to fill the spaces between the templates to within about an inch of the template edges. Next, fine finish plaster was used to bring the plaster medium past the template edges. Finally, the finish plaster was swept in, to expose the edges of the templates, and heavy reference lines were scribed into the surface of the mock-ups before they were sealed.

Upon completion of the mock-ups, plaster casts were made of each one, thereby obtaining female moulds of the outside mould lines of each part. These casts were attached rigidly to stiff welded steel frames for handling purposes, and to

* Chief Engineer, Zenith Plastics Co., Gardena, California.

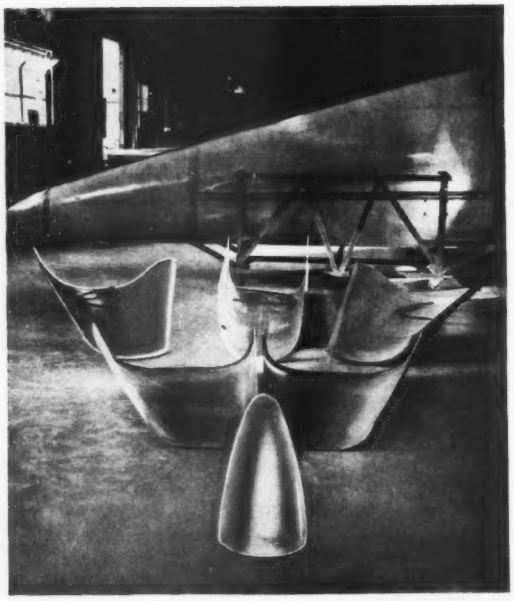


Fig. 3
(Left) The six major sections that make up the "stinger tail" structure are laid out in front of a completed assembly. The removable tail cone section in the foreground houses the recognition lights of the aircraft.

Fig. 4
(Above) The upper forward fuselage section is moulded in this metal-sprayed tool. The dark lines in the mould surface are for reference in laying up the glass fabric honeycomb sandwich structure. Such a tool takes the place of all the dies and fixtures required to make a metal semi-monocoque part — stringers, frames, etc.

Fig. 6
(Below) Unattended, this portable automatic thickness router accurately machines thicknesses on compound curves and on straight or flat panels.

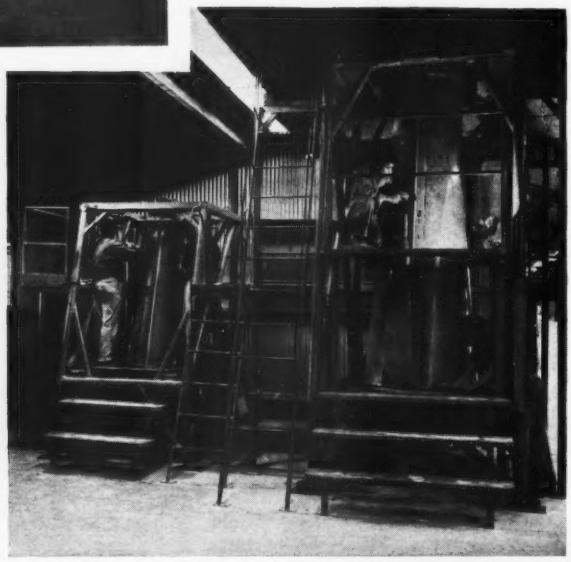
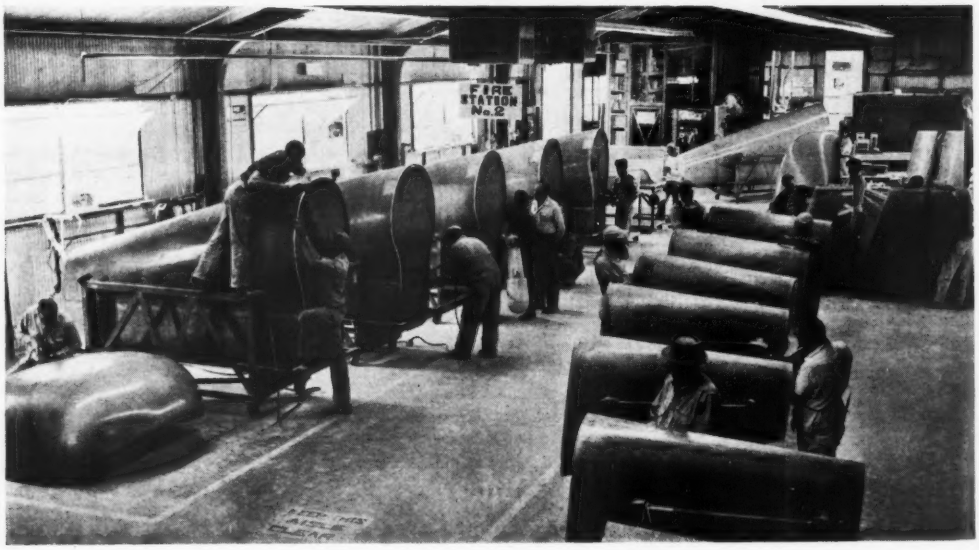


Fig. 5
(Left) These final assembly fixtures are the most complex tools used to produce the "stinger tails." Two complete reinforced plastic structures are processed in them in one day.

Fig. 7
(Right) The space required for final assembly of the "stinger tail" fuselage structure is 5,600 sq. ft. The absence of expensive aircraft-type fixtures may be clearly seen here.



eliminate any possible warpage. After the casts were thoroughly dried, duplicates of the mock-ups were cast in plaster. To each of these duplicates, another stiff welded steel structure was attached, similar to the ones used on the casts.

When the duplicates were thoroughly dried, the reference lines transferred to them were accentuated before the metal spraying was begun. These duplicates were used as the base for the deposit of the mould metal. In metal spraying them, a flash coat of zinc was first deposited. This was followed by a build-up of about 3/16-in. of bronze. Then, to provide additional strength and metal on the moulds, aluminium was sprayed on top of the bronze, so that the final thickness of metal was between half-inch and one inch.

The amount of metal that is sprayed on such moulds, and its distribution, is dependent upon the heat required to cure the part that will be produced in the mould. Careful consideration must be given to parts that have varying material thicknesses, local build-ups of solid laminate, and similar details. Other factors to be dealt with are distortions from the original shape caused by the varying temperatures to which the moulds are subjected, porosity of the mould surface, its strength and durability.

After the metal spray operations were completed, a one-inch thick shell of laminated glass cloth impregnated with Bakelite polyester resin was laid up over the exposed metal surface of each unit. These back-up shells adhered to the metal with the aid of adhesives and through the action of the resin, thereby adding considerably to the strength of the moulds. Rigid metal frames equipped with castors to facilitate moving the moulds were then attached to the reinforced plastic back-up shells with laminated glass cloth strips impregnated with resin, thus completing the mould structures. The plaster duplicates were removed, and the moulds were set upright on their castors.

The final clean-up and preparation of the moulds for production consisted of polishing out the flash coats of zinc, trimming the edges of the moulds, installing vacuum lines and resin traps, accentuation of reference lines, etc. Polishing off the zinc coating left the hard, smooth, dense bronze for the mould surfaces. Thus was created one tool for each section, which was all that was required to produce that complete section of the fuselage structure. In this manner, one tool replaced the large number of tools needed to produce the equivalent metal structure—replaced the hydropress dies for frames and bulkheads, extrusion dies and rolls for stringers, forming dies for skins, drill jigs, and rivet fixtures. (See Fig. 4.)

About the time the moulds were completed, the tooling department finished the two assembly fixtures which, because no stringers, frames, or bulkheads exist in the structure, incorporated facilities for drilling mating holes.

One fixture was used for the forward structure, consisting of the top section and two side sections. All three sections were joined together through rows of bolts passing through holes drilled for interchangeability in solid laminated glass fabric areas. At the front edge of the forward structure, aluminium alloy extruded angles were riveted to the sections and drilled to accommodate bolts that attach the "stinger tail" to the main fuselage structure of the aeroplane. At the rear edge of this structure, a built-in solid laminated glass cloth angle acted as an attachment ring for the aft section. This laminated ring was also drilled in this fixture for bolts that attach the aft section to it. The other assembly fixture had similar features, but was smaller and somewhat simpler than the forward structure fixture. Both fixtures resembled major assembly tools commonly used in metal aircraft construction. (See Fig. 5.) However, because of the simplicity inherent in reinforced plastic structures, they also took the place of drill jigs, sub-assembly fixtures, rivet fixtures, and other costly, space-consuming tools required to put a semi-monocoque metal aircraft together. With the completion of the assembly fixtures, the major part of the arrangements to produce the "stinger tails" was done All that was left was to make sure that the tool rooms had two ¼-in. drill motors, two small rivet guns, drills, sanders, heat lamps, small hand tools, and a couple of portable automatic thickness routers to use on the close tolerance lap joints.

This thickness router is a patented device developed by Zenith engineers to minimize the cost of producing close tolerance thicknesses on curved parts. It has indices that can be set to follow the contour of any part on which it is mounted, virtually unattended. Power is derived from an air motor fed by a flexible air hose attached to the plant air supply. The machine is small, lightweight, and yet extremely durable. It was designed for work on reinforced plastics materials which, because of their toughness, wear cutting tools rapidly, but it can also be used on all types of metals. (Fig. 6.)

Production planning called for a five-day work week for one shift consisting of 35 men. The total amount of floor space required to produce two complete fuselage structures in this time was set at 12,500 square feet. These manpower and space requirements were but a small fraction of that utilized in the production of an equivalent metal structure. (See Fig. 7.)

After all production tools were carefully checked and proved, the crews were organized, and the production lines set up. In a relatively short time (security restrictions prohibit exact data), full production was attained.

The moulding processes used to produce the five sections that make up this fuselage structure are time-proven at Zenith. While the moulds were being cleaned and coated with mould release agents, the glass cloth was automatically impregnated with polyester resins and the resin-treated glass cloth honeycomb, which was pre-cut to the proper thickness on a bandsaw, was brought from the stock bins. The impregnated cloth was then laid out on work tables over a heavy brown paper later used in handling the cloth. The desired number of plies was built up first for the outer skin. After all air pockets and wrinkles were worked out of the laminate, it was transferred to the mould. The pre-cut honeycomb was laid on this laminate, making allowances for solid built-up sections. Next, another impregnated laminate was laid on the honeycomb to form the inner skin of the honeycomb sandwich structure, and the entire contents of the mould were covered with a thin transparent plastic sheet that was hermetically-sealed around its extremity, which came to the edges of the mould A vacuum line was attached to the mould. Thus, atmospheric pressure was applied to its contents, and excess resins and gases were drawn off through traps. Blankets between the transparent plastic sheet and the inner skin prevented them from being joined together. The mould was then rolled into accurately-controlled curing ovens—a few hours later, it was removed and cooled.

Immediately after removal from the mould, the section was rough-trimmed with bandsaws to remove excess materials. Most final trim operations were done with the portable automatic thickness routers, and in simple tools. Trimming completed, the sections were put together in the assembly fixtures. From these fixtures, they were easily transported, because of their strength, stiffness, and light weight (two-thirds the weight of the lightest practical metal equivalent) on simple dollies, to the paint shops, where they were painted to match the colour of the aeroplane. (The reinforced plastic materials used in this fuselage structure are impervious to the extreme climatic and environmental conditions encountered in service by a U.S. Navy aeroplane—actually therefore, no protective coating is necessary.)

Finally, the forward sections and the aft sections were shipped, assembled, to Lockheed Aircraft Corporation for assembly of the complete aircraft.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

A Tribute to William Adam

SIR,—Many of us who have known him will deeply regret the passing of Bill Adam, and I know that many of the great number of people whom he knew personally would like to join me in paying a tribute to a very charming and understanding person, who was a friend, confidant and veritable helpmeet to so many.

William Adam.

In my experience over 20 years I found that nothing was too much for Bill Adam in helping a friend, and although he has been a little less amongst us during the past few years we all miss him and realise that there is no one to take his place.

H. W. GILBERT-ROLFE,
Director and General Manager.
Prestware Ltd.
Merton,
London, S.W.19.

High-frequency Welding of Polythene

SIR,—We would be most obliged if you would help us by recommending any manufacturers of heat-sealing machines suitable for use on polythene film, with special reference to the continuous and/or high-frequency type.

E. SYDNEY HEATH.
Sneyd Mills,
Burslem,
Stoke-on-Trent.

Clips for Curtain Drapes

SIR,—I am interested in obtaining plastic clips for draping back nylon net curtains. I wonder if you could inform me of any firm manufacturing these.

MRS. YVONNE REGNIER.
276 Bisphem Road,
Bisphem, Blackpool.

Extrusion of Nylon

SIR,—We are interested in the article on the extrusion of nylon in *Plastics*, December, 1953. Are you able to help us, please, by letting us know of any firms who are extruding this material?

We are interested in the possible application of it as slot wedges in electric motors.

WOODS OF COLCHESTER LTD.
Colchester,
Essex.

Grinding of Acetate-butyrate Rod

SIR,—We would be very much obliged if you would let us know a possible contact for the centreless grinding of 6- and 4-fluted cellulose-acetate-butyrate rodding. The rodding is to be in an extruded form in 8-ft. lengths supplied by ourselves.

TENAPLAS LTD.
Upper Basildon,
Near Pangbourne,
Berks.

P.v.c. Films and Plastic Foils

SIR,—I should be greatly obliged for your kind help in giving me the names and addresses of British manufacturers of semi-rigid p.v.c. film, plain and embossed, and plastic foils for curtains and raincoats, and kindly include smaller manufacturers.

MARTIN HERTZ.
Chr. 1X Gade 6,
Copenhagen, K,
Denmark.

Continuous Blanking Machine

SIR,—We wish to obtain a continuous blanking machine suitable for cutting small irregular shapes from extruded p.v.c. The shapes vary in size from discs approximately ½ in. diameter to more complex shapes covering an area of 2 or 3 sq. in.

PLYSU PRODUCTS LTD.
Woburn Sands,
Bletchley,
Bucks.

Hardness Testing of Plastics

SIR,—In an article with the above title, published in *Plastics*, September, 1953, page 53, I described various methods of hardness testing suitable for plastics materials. Data were given of test results obtained with a micro-hardness tester developed by Industrial Distributors (Sales), Ltd. This instrument employs a sensitive method of depth measurement under load and is further equipped with a device for continually increasing the load during the test, ultimately supplying a record of the depth of penetration obtained under certain loads. The instrument is also capable of recording the rate of recovery under decreasing loads. The accompanying illustration, which was not included in the original article, shows a load-creep recovery diagram obtained on a nylon test piece. The diagram reveals the following conditions:—

In section A the load was increased from a pre-load of 50 gm. at 1 to a maximum load of 100 gm. at 2. During this period the diamond edge penetrated the material by a depth of 2.7 micron. The total load of 100 gm. was now pressing on the indenter during a period of 50 sec., section B (points 2-3). During this time the indenter penetrated the material approximately 1 micron deeper. The rate of creep was 1/65 micron/sec. Period C was used to remove the load to the pre-load of 50 gm. This was done by hand and therefore caused a certain delay and small vibrations. It is intended ultimately to perform this operation mechanically, so that point 3 would then take the position 3_1. From 3_1 to 4 the load was removed. From point 4 onwards only the pre-load of 50 gm. was acting and the material was recovering at a rate of 1/240 micron/sec. Thus the rate of recovery was under the given conditions only about ¼ that of the original creep or flow.

PAUL GRODZINSKI.
41 Tudor Close,
London, N.W.3.

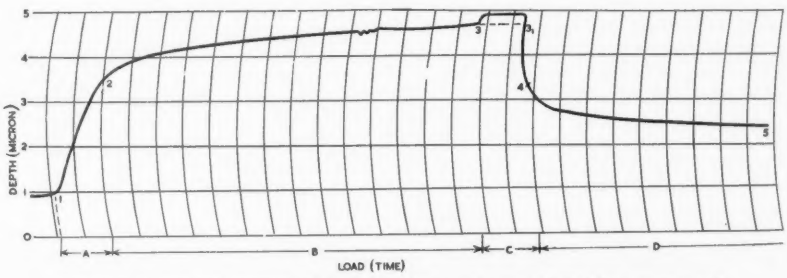
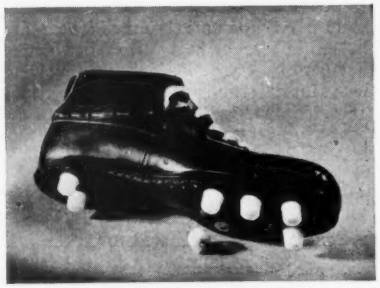


Diagram of load and removal of load on nylon; each vertical division corresponds to 3.75 sec. or 31.25 g. load.

New Productions

Nylon Football Studs

Moulded nylon studs are replacing leather studs for football boots. Two ranges of boots, the Cotton-Oxford and the Arthur Rowe boots, both manufactured by Headlam and Sims Ltd., are now being fitted with these studs. They are claimed to last many times longer than the leather type without losing their shape and they wear smoothly throughout. There are no nails which might stand proud or drive into the wearer's foot; every stud incorporates a metal insert which screws into a recess fitted on the sole of the boot. The studs are particularly effective on muddy pitches, two sizes being available to suit different conditions. With the screw fitting it is a simple matter to change from one to the other. On hard or sandy ground nylon offers better resistance to abrasion than leather. The nylon mouldings are produced by the General Electric Co., Ltd., at Witton. Permission for use of the studs has been granted by the Rugby Union and several of the visiting New Zealand team



Football boot with nylon studs.

were using them. In soccer clubs nylon studs are used in practice games and F.A. sanction for their use in league matches is being sought.

Lighting for Underground Trains

Most of the trains running on the London underground system were built before the 1939/45 war. Lighting for the interiors of the carriages was designed and manufactured by Benjamin Electric, Ltd. The shovel-type shades are made to slide easily in metal runners so that they can be removed readily for cleaning. The shades were originally made of white translucent glass but these were frequently chipped or cracked particularly during removal or replacement for cleaning. This fact together with the temporary shortage of glass after the war led Benjamin Electric Ltd., to investigate plastics as an alternative material for replacing damaged glass shades. With the rising costs of the transport organization low cost was an essential consideration. Shades shaped from opal Perspex sheet were successful in use but the quantities required were sufficiently large to make injection-moulded Diakon acrylic material more economical—in fact cheaper than glass. A further saving has now been made possible with very little reduction in light transmitted properties by moulding in polystyrene. This has brought the cost of the shades below the pre-war price of glass shades. The mouldings are made for Benjamin Electric Ltd., by a large trade moulding company on a Peco injection moulding machine.

Clipall clothes peg.

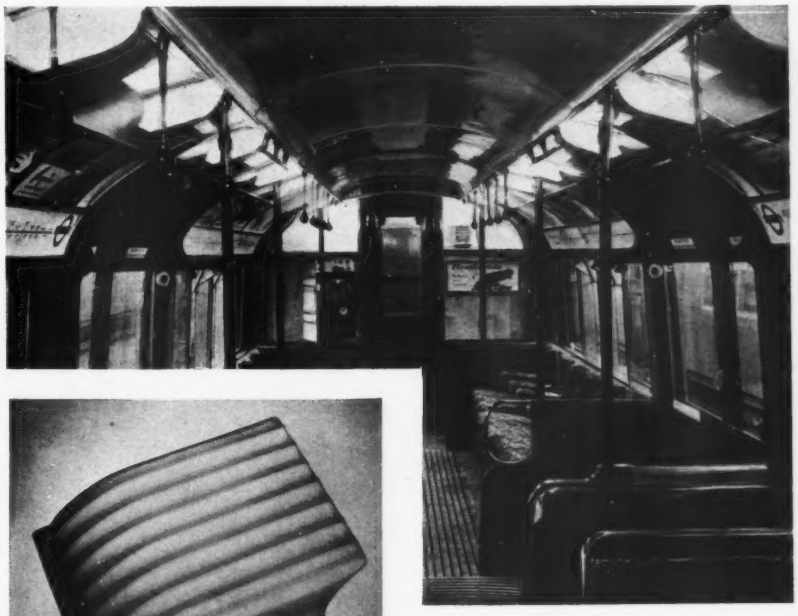
(Right) Demonstrating the porosity of resin-treated battery separator plates. (Photo from "Power to Spare," published by Oldham and Sons, Ltd.)

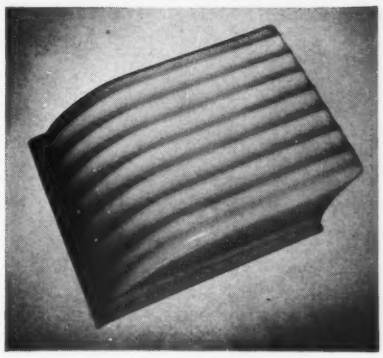
Clothes Peg

The "Clipall" clothes peg which has been developed by Leetex, Ltd., 39 Great Pulteney St., London, W.1, consists of a strong steel spring fitted with polystyrene ends to give a strong smooth clip. The pegs are produced in different colours by J. F. Kenure, Ltd., Fagg's Road, Feltham, Middlesex. Both by their neatness in appearance and strength they offer great advantage over conventional wooden pegs.

Battery Separators

The most important advantage in the design and construction of electric storage batteries in recent years has been the improvement in efficiency and durability of the materials used to separate the battery plates. These have conventionally been made of a specially selected wood imported from the U.S.A. but despite care in selection and treatment the wooden separators were





"Shovel" shades for London Underground trains: (above) interior of a carriage showing lighting fittings in position; (left) a moulded shade.

frequently the first part of the battery to fail. Experiments have led to the development of both microcellular rubber and microcellular polyvinyl chloride separators. Oldham and Sons, Ltd., have, however, developed a method of treating the wooden separators with phenolic resins in such a way as to increase their durability without impairing the porosity required for efficient working. Our illustration shows a demonstration of this porosity.

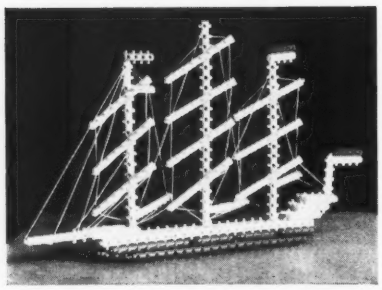
Toy Telephone

The clockwork telephone moulded by Airfix Products Ltd., can be wound up, and gives a real ringing sound when a button is pressed. The base and handset are moulded in contrasting colours of polystyrene.

Polystyrene toy telephone.

Lighting for Railway Station

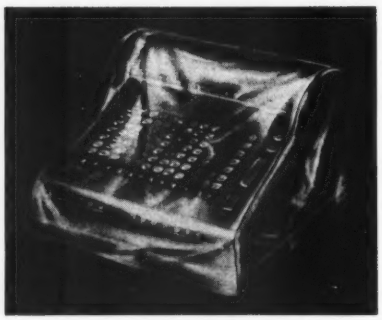
A new lighting installation at Fenchurch Street Station, London, is the first to employ cold cathode lighting in a main line station. A new form of lighting fitting has been developed by Ionlite, Ltd., at the request of the mechanical and electrical engineers department of British Railways, Eastern Region. Perspex fittings have been used extensively throughout this station. The design of this large "Hilite" concourse fitting is particularly suitable to station lighting where cleaning is a major problem. The new Hilite fittings are totally enclosed, each consisting of a sphere approximately 37 in. in diameter moulded in two sections, the top in .040 in. Perspex and the lower half in 0.030 in. Perspex. The shaping of the bowls was carried out by Thermo-Plastics, Ltd., Dunstable. The minimum of metal parts have been used to reduce corrosion damage from sulphurous fumes encountered in such situations. The design gives controlled spherical light distribution with a noticeably higher output in the lower hemisphere.



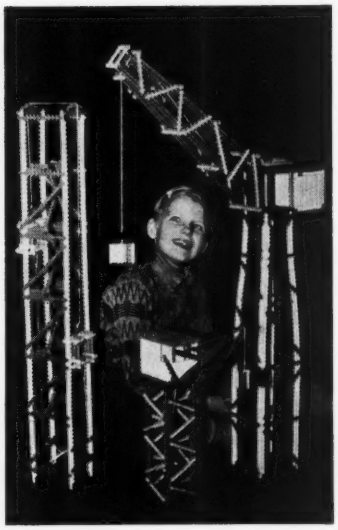
Danish constructional toy, consisting of moulded plastics sticks. Examples of finished models are shown above and right.

Covers for Office Equipment

Dust covers for typewriters, accounting machines, dictating machines and similar office equipment are now being produced from thin flexible polyvinyl chloride sheeting. The accounting machine illustrated has a translucent cover produced for the machine manufactured by Plysu Products, Ltd., Woburn Sands, Bletchley, Bucks. The cover is made by r.f. welding and is tailored to the contour of the machine. P.v.c. gives a cheap, light and strong cover available in any colour to match the colour scheme of the machines. It is easily cleaned and can be folded into a small space for putting away whilst the machine is in use.



Dust cover for accounting machine.



Constructional Toy

A novel constructional set produced by Bengros A/S, Copenhagen, Denmark, consists of a length of hollow sticks with holes and lugs on alternate sides. These are moulded in plastics in a variety of colours. Assembly is extremely simple involving merely the insertion of the short lugs into the corresponding holes. As can be seen from our illustrations, quite elaborate structures can be assembled.

All-purpose Torch

A new torch produced by the General Electric Co., Ltd., is claimed to be the first made in Great Britain with the light source projected at right angles to the battery housing. An advantage of this design is that the torch can be attached by means of a metal clip to the user's clothing or set down on its base and can also light up corners inaccessible to conventional torches. The body is injection-moulded in cellulose acetate by the Witton Moulded Insulation Works, G.E.C. The moulding has an unusually deep cross section which, in conjunction with the resilient properties of acetate, ensures resistance to heavy wear. The window is moulded in polystyrene, gaskets ensure that the torch will withstand the worst outdoor conditions.

Hilite fitting with Perspex bowl.

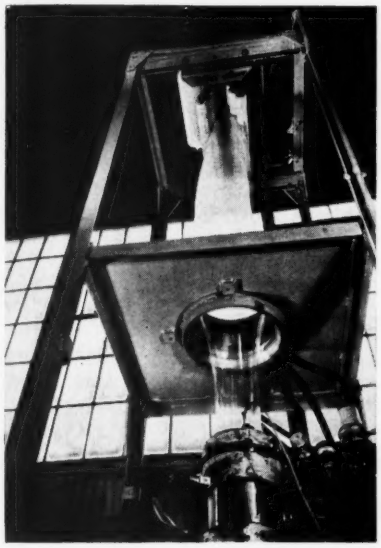
New lighting installation at Fenchurch Street Station, London.

All-purpose torch.

Plastics NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

EXTRUDER DEVELOPMENTS.—Since the introduction of the Peco 2½ in. extruder last year, further development has been carried out for various special applications. The illustration published herewith and the one published on the contents page of this month's issue of *Plastics*, show the extrusion of polythene lay-flat tubing. The



Extruding polythene lay-flat tubing with 2½ in. Peco machine.

film can be clearly seen leaving a die-head and passing through a cooling plate. Air is pumped in through the underside of the die to give the requisite tube diameter. At the top of the photograph can be seen the reeling-up assembly.

HARD NICKEL ELECTROFORMED MOULDS.—Following the visit of Mr. P. Spiro, of the London and Scandinavian Metallurgical Co., Ltd., to Sweden last year, a number of moulds have been ordered by Swedish companies. Amongst the more interesting ones is a two-impression mould for the 3-dimensional horn button of the Volvo car. Ordered against a six weeks delivery, the mould arrived by air on the day promised.

T. H. AND J. DANIELS, LTD., have recently been appointed sole agents in Great Britain for the Italian Pasquetti twin-screw compounder extruders.

COURSES IN TOOL TECHNOLOGY.—After discussions with engineers and executives in industry, and with the Gauge and Tool Makers Association, it is proposed to establish courses in the technology of tooling as it applies to the instrument and light engineering industries, at the National College of Horology and Instrument Technology, Northampton Polytechnic, London, E.C.1. Industrial organizations are being circularized in order to assess the precise demand for such courses. Full details of the certificate and diploma courses, both embracing two years' full-time study, are obtainable from the secretary of the Polytechnic.

ELECTRICAL EXHIBITION.—The 3rd Electrical Engineers' Exhibition organized by the Association of Supervising Electrical Engineers is being held at Earls Court, London, from March 16 to 20. One of the exhibitors will be Londex Ltd., manufacturers of electrical remote-control units, and their display on Stand 102 will include electronic relays, sensitive pressure switches and process timers of various types.

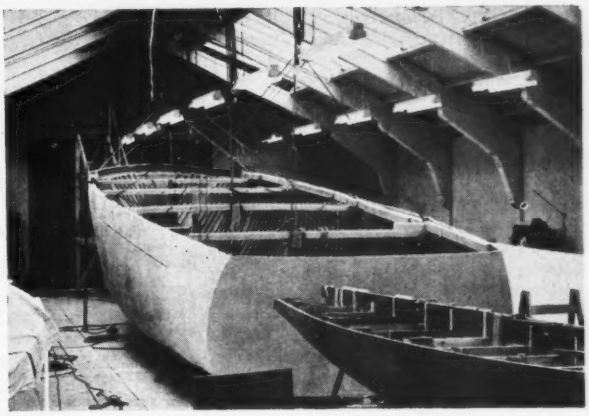
W. W. BALL AND SONS LTD., of Billericay, Essex, have commenced the erection of a new extension to their present factory to accommodate the expansion of their tool-room and moulding shops. The company has been engaged in the manufacture of tools and mouldings for over 30 years.

NEW LOW-TEMPERATURE PLASTICIZER.—British Industrial Solvents have introduced Bisoflex 102 (triethylene glycol dicaprylate), having specific gravity 0.975-0.980. The plasticizer is insoluble in water but is readily miscible with all the main organic solvents and is compatible with a range of polymers, including polyvinyl chloride and polystyrene. The technical leaflet, obtainable from the company at 4 Cavendish Square, London, W.1, contains some interesting test figures in relation to Geon 101.

PLASTICS FLOORING SPECIFICATION TO BE SET UP.—At the suggestion of members manufacturing plastics flooring, a committee is being set up by the British Plastics Federation to prepare a specification for plastics flooring for submission to the British Standards Institution. This committee will be the technical committee of a new sub-section of the Federation to be known as the Flooring Sub-Section of the General Fabricators' Section of the Fabricators' Group. Another sub-section will be known as the Packaging Sub-Section.

DUTCH COMPANY TO MANUFACTURE TERYLENE.—Imperial Chemical Industries Ltd. have concluded a licence agreement with Algemene Kunstzijde Unie N.V., Velperweg 76, Arnhem, the Dutch manufacturers of rayon and nylon, under which the latter company will have the right to manufacture in the Netherlands and Belgium the new polyester fibre known in this country as Terylene.

DEBORINE HULLS.—Deborine, the trade name for glass fabric reinforced polyester laminate fabricated by Halmatic Ltd., Portsmouth, has been widely employed in fast construction. Tests carried out indicate that, weight for weight, the glass-resin laminate, whilst only half the thickness, is stronger than wood. At a recent demonstration a 45-ft. hull was shown, designed by Commander Peter Thornycroft. This hull is to be finished as a sea-going yacht capable of sleeping six people. The hull was manufactured with the aid of unskilled labour in 15 working days, and is shortly to be towed across the Solent by Attrill and Sons of Bembridge, where the engine will be fitted and the yacht completed.



(Right, above) A view of the 45-ft. hull fabricated from glass fabric reinforced polyester laminate by Halmatic Ltd. (Right) Interior of hull can be seen.

(Left) Streetly Manufacturing Co., Ltd.'s stand at the Hotel and Catering Exhibition, on which was featured melamine tableware.

(Right) Stand of De La Rue Ltd. at same exhibition. Formica was the central feature.

THE HOTEL AND CATERING EXHIBITION.—Several plastics companies took part in the Exhibition held at Olympia from January 20 to 29. Although many displays were marred by lighting difficulties, it is reported that business was very favourable. Amongst the companies represented were Streetly Manufacturing Co. Ltd., Thos. De La Rue and Co. Ltd., I.C.I. Ltd., and Thermo-Plastics Ltd.

OIL AND COLOUR CHEMISTS' ASSOCIATION EXHIBITION.—The 6th technical trade exhibition will be held at the Royal Horticultural Hall, London, S.W.1, from April 21 to 23. A number of companies in, or associated with, the plastics industry, will be taking part.

British Industrial Plastics, Ltd., will be showing the use of the Dean and Stark apparatus for the determination of relatively small quantities of water. In the preparation of many resins used in the paint and varnish industry, azeotropic distillation is often used where the rate of distillation and quantity of water removed is considerable; to provide the best reaction conditions the immiscible solvent must be separate and returned to the reaction, whilst the water is continuously removed. A laboratory apparatus satisfying these requirements of azeotropic distillation and separation by a simple automatic decanter is shown in operation. Another useful piece of apparatus to be seen will be a filter for resins, capable of handling quantities as small as 500 c.c. with a minimum loss. Of the Bettle urea, melamine and alkyd resins made by the company, the range of melamine resins for finishes has been chosen for special illustration. The comparison correlation of their various properties and compatibilities with different film-forming materials is demonstrated.

The main display of Monsanto Chemicals, Ltd., will feature the Lustrex latices for the formulation of high polymer emulsion paints. Other products to be displayed will be the protective colloid Lustrex X820 and Aroclors for use as plasticizers. The scrub resistance of Lustrex latices will be demonstrated with a working display on a variety of panels and a number of emulsion paints will be on display. In addition to these highlighted products information will be available on the full range of Monsanto chemicals.

Johnson, Matthey and Co., Ltd., will trace the development of pigments based upon cadmium, from the discovery of natural cadmium sulphide up to the present day, by means of an historical sequence. Particular attention will be drawn to the improvements effected in the brightness and cleanness of these pigments in recent years and to the greatly expanded uses they now find. Many examples of typical products coloured with cadmium sulphide or sulphoselenide pigments will be displayed, and the outstanding properties of the pigments—resistance to light, to heat and to chemical action—will be demonstrated.

R. H. Cole and Co., Ltd., will be showing samples of raw materials used in surface coatings.

UTILEX LTD.—We have received a copy of the company's latest booklet devoted to cellulose acetate sheet and film. Copies are obtainable from the company at Mill Street, Kingston-on-Thames, Surrey. Apart from much useful information on applications, well illustrated by photographs, the booklet schedules a comprehensive list of mechanical, electrical and chemical properties and will be of interest to all who fabricate acetate material in sheet and film form.

"A NEW RANGE OF EXPANDED RESINS."—This article, published in the February issue of *Plastics*, has aroused much interest. Mr. D. N. Hunter, the author, who has been investigating the properties of these resins in his spare time will be pleased to receive correspondence on this subject at his home, at 4 Hurst Way, Leagrave, Luton, Beds.

BAKELITE DIRECTOR.—Mr. Leon Kenneth Merrill has been co-opted to the board of Bakelite Ltd., following the resignation of Mr. Howard S. Bunn.

CONSULTANT TO PULVERIZING INDUSTRY.—Mr. E. D. W. Kidd is now available for consultation of problems connected with crushing, grinding, chipping, mixing and drying of most types of raw materials used in industry. Mr. Kidd's address is "Weymede," High Road, Byfleet, Surrey; telephone number Byfleet 3086.

TELCON BOARD CHANGES.—The Telegraph Construction and Maintenance Co., Ltd., announce that Mr. J. N. Dean has been appointed deputy chairman of the company. The executive duties of the board will no longer be vested in a managing director, but will be carried out by a managing board, of which Mr. Dean, as Chief Executive, will be chairman.

MR E. G. COUZENS was awarded the O.B.E. in the New Year Honours List. Formerly head of the research and development department of BX Plastics Ltd., he became managing director of Bexford Ltd. in 1946. In 1951 he became the technical director.

NEW DIRECTORS FOR W. A. MITCHELL AND SMITH LTD.—Mr. A. E. Cooper and Dr. S. R. W. Martin have joined the board of the company, which is in the process of erecting two new plants, one for the manufacture of alkyd resins and the other to expand production of modified pheholic and maleic resins.

THE GREENWICH LEATHERCLOTH CO., LTD.—Mr. H. France (Director of the Bleachers' Association, Ltd.), Dr. R. A. Herbert, Mr. H. Holton and Mr. R. S. Colborne, have been appointed to the board of the company.

Plastics in the Service of Man

In answer to numerous requests we are publishing a list of full names and addresses of companies mentioned in the illustrated feature "Plastics in the Service of Man" which appears on pages 76 to 79.

46. Tools and Engineering Components—II

Aero Research Ltd., Duxford, Cambridge.
Anglo-Scottish Tool Co., Ltd., Kingsway, Team Valley, Gateshead, 11.
Ashdowns Ltd., Knowsley Road, St. Helens, Lancs.
Ball, W. W. and Sons, Ltd., Burstead Works, Billericay, Essex.
Catalin Industrial Resins, Ltd., 54 Farm Hill Road, Waltham Abbey, Essex.
Crane Packings Ltd., Slough, Bucks.
Creators Ltd., Sheerwater, Woking, Surrey.
Evans, Frederick W., Ltd., Long Acre, Birmingham, 7.
Elliott-Lucas, Ltd., 19 Frederick Street, Birmingham, 1.
Fraser and Glass, Ltd., Woodside Lane, North Finchley, London, N.12.
Gordon Tools, Ltd., Assam Works, Sheffield.
Hordern - Richmond, Ltd., Haddenham, Bucks.
I.C.I., Ltd., Plastics Division, Welwyn Garden City, Herts.
Kent Mouldings, Footscray, Sidcup, Kent.
Kimball, A., Co., Ltd., Ealing, London, W.5.
Kodak, Ltd., Kingsway, London, W.C.2.
Lacrinoid Products, Ltd., Stafford Avenue, Gidea Park, Essex.
Lincoln Electric Ltd., Broadwater Road. Welwyn Garden City, Herts.

Litholite Insulators and St. Albans Mouldings, Ltd., Sandown Road, Watford, Herts.
Melwood Thermoplastics, Ltd., Willoughby Road, Harpenden, Herts.
Mellor Bromley and Co., Ltd., Leicester.
Molins Ltd., Evelyn Street, London, S.E.8.
Morris Motors (Radiators), Ltd., Woodstock Road, Oxford.
Motor Panels (Coventry), Ltd., Holbrook Lane, Coventry.
Nuffield Metal Products, Ltd., Common Lane, Birmingham, 8.
Plastic Engineers, Ltd., Treforest, Glamorgan.
Punfield and Barstow (Mouldings), Ltd., Westmoreland Road, London, N.W.9.
Stanley Works (Great Britain), Ltd., Woodside Lane, Sheffield, 3.
Tufnol Ltd., Wellhead Lane, Perry Barr, Birmingham, 22B.
Walter Machines, Ltd., 1-3 King's College Mews, London, N.W.3.

MEETINGS

March

13th.—"Description and Uses of a Research Experimental Plant, H. J. Thurlow. Institution of Chemical Engineers, North-Western Branch, Manchester.

15th.—Symposium on "Processing Techniques in Reinforced Plastics," J. E. Gordon, B.Sc.(Glas.), and A. E. Dean, A.P.I. Plastics Institute, London Section, Waldorf Hotel, Aldwych, London, W.C.2. 6.30 p.m.

16th.—"New Kinds of Macromolecules," Professor H. W. Melville, D.Sc., F.R.I.C., F.R.S. Royal Institute of Chemistry, joint meeting with the Society of Chemical Industry, London Section. Hatfield Technical College, Welwyn Garden City, Herts. 8 p.m.

17th.—"The Mechanical Properties of Plastics," R. Hayes, B.Sc., A.R.C.S., British Resin Products Ltd. Plastics Institute, Western Section, Technical College, Gloucester. 6.30 p.m.

17th.—"Recent Developments in Contact Resins," G. C. Hulbert, B.Sc., Scott Bader and Co. Ltd. Plastics Institute, Scottish Section, Institution of Engineers and Shipbuilders in Scotland. 7.30 p.m.

18th.—"Some Aspects of Astronomical Instruments," Mr. Sisson of Grubb Parsons. Plastics Institute, North-Eastern Section, The Neville Hall, Newcastle upon Tyne. 7 p.m.

19th.—"Polyester Resins, Their Properties and Applications," L. H. Vaughan, A.R.I.C., Bakelite Ltd. Plastics Institute, Midlands Section, Birmingham.

24th to 26th.—Symposium on "Chemistry and Physics of Synthetic Fibres." Society of Chemical Industry, Plastics and Polymer Group, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. 10 a.m. to 5 p.m.

26th.—Dinner Dance, Plastics Institute, Midlands Section. Chadwick Manor Hotel, Knowle.

26th.—"Low Pressure Moulding," R. Wareing, Marston Excelsior Ltd., Wolverhampton. Plastics Institute, North-Western Section. 6.30 p.m.

April

1st.—"Krilium Soil Conditioner—Improving Soil Structures," Dr. W. McG. Morgan. Plastics Institute, Southern Section, Polygon Hotel, Southampton. 7.30 p.m.

7th.—Cameo meeting, lectures to be given by section members. Plastics Institute, Yorkshire Section, St. Mark's House, 186 Woodhouse Lane, Leeds, 2. 7 p.m.

7th.—"Resins for Rubber," E. M. Evans, B.Sc., Ph.D., A.R.C.S., D.I.C., F.R.I.C. Plastics Institute, South Wales and Monmouthshire Section, Newport Technical College. 7 p.m.

13th.—"Vinyl Acetate and its Derivatives," Dr. O. Horn (Farbwerke Hoechst). Society of Chemical Industry, Plastics and Polymer Group, Burlington House, Piccadilly, London, W.1. 6.30 p.m.

40 Years in the Plastics Industry

THE story of H. V. Potter is the story of the plastics industry, with which he has been associated for nearly 40 years.

On January 19, 1914, he was appointed research chemist to the newly established Damard Lacquer Co. producing resins in solution to make lacquers for the protection of brass fittings—mainly brass bedsteads and spun brass articles.

The war brought a demand from the Admiralty for synthetic insulating varnishes for the manufacture of paper-based laminated sheet for electrical insulation. This was a product designed to meet the demands of the growing electrical industry. The company took over a factory at Cowley, Middlesex, and, with improved equipment, expanded its output. During this period they commenced experiments in the manufacture of moulding powders, which in those days consisted of a mixture of synthetic resin and ordinary sifted sawdust.

At the end of the 1914-18 war, the company returned to Birmingham, building a new factory on a one-acre site at Greet. Here the manufacture of lacquers and varnishes was continued, and the company turned its attention to the manufacture of moulding materials.

Just before Mr. Potter joined them in 1914 the Damard Lacquer Co. commenced the manufacture of lacquers in New Jersey, U.S.A. However, war-time difficulties forced them to discontinue manufacture there in 1916. This venture was of importance as it led to meetings with Dr. Baekeland during visits to the United States in 1915 and 1916, the consequences of which were very far reaching.

Dr. Baekeland, who had been working on phenolic-formaldehyde products, gave the Damard Lacquer Co. permission to use his patents and trade mark during the war. The friendship thus established was destined to have a far-reaching influence on the Damard Lacquer Co. and Mr. Potter. One of the earliest results was the merger of the Mouldensite Co. of Darley Dale and Redmanol, Ltd., of London—selling agents for the American company of the same name—with the Damard Lacquer Co. and the formation of Bakelite, Ltd., in 1927 with the participation of the Bakelite Corporation of America and others. Dr. Baekeland took a substantial financial interest in the new British company.

Mr. H. V. Potter

Mr. Potter had been appointed manager of the Damard Lacquer Co. in 1915 and subsequently a director; he was now appointed managing director of the newly formed Bakelite, Ltd.

The new company acquired a 27-acre site at Tyseley, Birmingham, built a new factory, and concentrated there the manufacture from Greet and Darley Dale. Not satisfied with the quality of laminated insulating materials then available in the country, Bakelite, Ltd., began to manufacture these materials for electrical and mechanical applications.

During the late war he was a member of the Advisory Committee on Plastics Control—set up by the Ministry of Supply—and of the "Chemical Ring Fence," as it was termed, in the Midland area, and also of the Chemical Industry Labour Supply Committee for the Midlands. Towards the end of the war he was chairman of the Committee established by Lord Portal—then Minister of Works—to study the possible applications of plastics in building in the immediate post-war years.

At the end of the war the company's main production facilities were again concentrated at Tyseley and at Ware in Herts. They also took over part of a Ministry of Supply factory at Aycliffe, Co. Durham, and later acquired an adjoining site, making a total of nearly 70 acres. Here has been built a plant for the manufacture of the new vinyl materials which assumed so much importance during the war.

Bakelite, Ltd., was converted to a public company in 1948, and Mr. Potter was appointed chairman and managing director in the same year.

Mr. Potter is a member of the British Plastics Federation, of which he was chairman in 1937-38, and he is a past president of the Plastics Institute. He is a founder chairman of the Plastics and Polymer Group of the Society of Chemical Industry, being chairman again in 1948-50, and of the Chemical Engineering Group in 1951-53. He is also a member of the Association of Chemical and Allied Employers, and was chairman of the Association and the Joint Industrial Council in 1952.

TALKING SHOP . . .

Mending P.v.c. Sheet. Now that p.v.c. rainwear is generally in great public demand a problem that often arises is to find a simple method of mending small tears in such garments. High-frequency welding would obviously give the best results, but unfortunately such machines are not yet as common as vacuum cleaners, washing machines or even sewing machines in the average household. Sewing p.v.c., on the other hand, is likely to cause further weakness in the sheeting unless special precautions are taken.

The transparent self-adhesive tapes based on p.v.c. sheet as a backing material might be satisfactory, but so far only tapes based on cellulose film appear to be commercially available; the plastics-backed tapes go to industrial users and the packaging of military equipment.

In view of the low cost of the average raincoat, it is doubtful whether a commercial mending service would be a sound proposition, but there may be some justification for someone with r.f. welding equipment to develop some service of this kind.

I should be very grateful if any readers who have an answer to this problem would send me their suggestions.

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U.S. Reinforced Plastics Conference. Following my note on the conference held at Stratford-upon-Avon recently for the exchange of information amongst British companies engaged in the production of glass-reinforced plastics, I was interested to receive from the Society of Plastics Industry, U.S.A., a report of the 9th Annual Technical and Management Conference of the Reinforced Plastics Division of S.P.I. The Conference was attended by 1,200 representatives of companies concerned with reinforced plastics. Concerning the export business of the industry, most manufacturers seemed highly confident, despite the general fear of a slight American recession. This was the opinion of boatbuilders, corrugated-roofing manufacturers and custom moulders concerned with production of trays, car parts, etc. The following figures showing consumption of polyesters were given and reflect the growth of the reinforced plastics industry:—

1945	3,500,000 lb. (entirely for military use)
1946	1,500 000 lb.
1947	800,000 lb.
1948	1,800 000 lb.
1949	4,500,000 lb.
1950	8,500,000 lb.
1951	14,000,000 lb.
1952	19,000,000 lb.
1953	26,000,000 lb.
1954	35,000,000 lb. (estimate)

Developments forecast this year include new resins, progress in pipe production, new reinforcements (chiefly synthetic fibres), and increasing use for metal tooling. The Reinforced Plastics Division of S.P.I. are sponsoring standardization in all fields. Another trend reported is the increasing capital and technical requirements required by a company to make a success in this field and the consequent change towards larger manufacturing units than the original backyard workshops where much of the early developments took place.

★ ★ ★

Flame-sprayed Polyamide Nylon Coating. Flame spraying of plastics, particularly polythene, has frequently been mentioned, considerable development work having been undertaken by Schori Metallising Process, Ltd. Schori are now introducing a type of polyamide, Nylon "R," which is obtainable in powder form and has been found suitable for flame spraying by their process. Nylon "R" produces homogeneous pore-free coatings with excellent electrical and chemical properties and above all with excellent heat resistance. It is insoluble in all oils and most solvents and is unaffected by boiling water. It has been found suitable for protecting equipment in the production of foodstuffs, especially for the prevention of ferrous contamination, and in many industries permits the substitution of mild steel for stainless steel. Another interesting application is the coating of mild steel heating coils in oil tankers, when in service have an oil temperature of 120° to 130° C. The coils are subjected to very rapid corrosion when the tankers are travelling in sea-water ballast as they frequently do. Until the use of the Nylon "R" coatings no satisfactory way had been found of protecting these mild steel or cast-iron heating coils in such difficult conditions. We understand that the polyamide used is a grade of Rilsan produced in France by Organico S.A.

★ ★ ★

Large Boat Hulls. In our news pages this month (page 89) is a report of a 40-ft. reinforced plastics boat hull produced by Halmatic Ltd., of Portsmouth. This appears to be one of the furthest advances in the plastics boat building field and is the result of development work which included the production of a "Flying 20" designed by Mr. Uffa Fox. The Deborine type of construction is noteworthy for the method of obtaining extra rigidity in the hulls. Thin aluminium sheeting is bent into the shape of formers for ribs. When laying up, glass cloth is shaped around these formers and when set the laminate—not the aluminium former—provides the box-shaped rib giving great rigidity.

★ ★ ★

Dust on Mouldings. A considerable worry for both moulders and those handling finished thermoplastic mouldings is the accumulation of dust encouraged by charges of static electricity on plastics, particularly polystyrene and acrylics. We recently asked several material manufacturers about their suggested remedies for this problem. Monsanto Chemicals, Ltd., have published a technical service bulletin, No. P62, dealing with anti-static finishes for polystyrene. This gives useful information on the way the charges are built up and on destaticizing agents both temporary and permanent. A solution of any of the common household detergents applied with a damp rag and not dried or polished appears to provide protection from dust for many days. This method is recommended as suitable for use in the home and in shops where plastics products are displayed. Other remedies include special buffing compounds, de-ionizing salt sprays and waxes. Permanent effects are claimed from certain types of lacquers, working on the principle of reducing the charge on the moulded piece so that the attraction of dust is reduced. Lacquers of this type are based on cellulose acetate butyrate dissolved in a mixture of solvents. Where the extra handling cost is justified this appears efficient and also improves the gloss and scratch resistance of the moulding.

★ ★ ★

Rolling Pin. A plastic rolling pin, described in several women's journals recently, is in five parts. When not used for its original purpose, it can be taken apart and the pieces used individually as a scoop, flour sifter, scone cutter and funnel.

★ ★ ★

Slimming Suit. The craze for slimming has brought an invention to England from America. An overall suit made from plastics sheeting retains body heat and causes the temperature inside the suit to rise above blood temperature making the wearer perspire freely—in fact providing a portable Turkish bath. The idea is being launched in England by Mrs. Stephanie Bowman, 133 Sloane Street, London, S.W.1.

★ ★ ★

Floats for Tanks. The U.S. Army Department has announced a new development to make 48-ton medium tanks amphibious. The tanks are equipped with floats made of foamed plastics with a density less than half that of balsa wood. Propellers on the floats are driven by the tank's engine. When the tank reaches the shore, the float wings can be discarded by exploding the pins holding them to the vehicle. The plastic material is claimed to withstand small-arms fire and limited artillery bursts. The crew, who are not exposed, are able to fire their 90-mm. guns and machine-guns while the tank is in the water.

★ ★ ★

Venetian Blinds. I understand that venetian blinds made from thin plastic strips (presumably extruded) are now on sale in Britain. So far, mainly extruded aluminium has been used since it was difficult to prevent slight sagging of thermoplastic slats under strong sunlight. An example shown by the Italian paper *Materie Plastiche* has slats of a reinforced box section, thus giving the necessary rigidity.

★ ★ ★

Protecting Printing Blocks. A quick-drying plastic solution has been developed by Corrosion Ltd., for applying a strippable coating to the surface of printing blocks for protection during storage.

★ ★ ★

Electric Blankets. A new electrically heated blanket has its elements fully encased in plastics. It has a controlled maximum temperature of 35° C. and is plugged in to mains electrical supply.

PLASTIKON.

The Function of the Pre-heater in Injection Moulding

The role of the pre-heater as an integral part of injection and extrusion machines has long been recognized as serving at least two purposes. Many of the methods employed to date have been crude, so that the new unit described below comes as a welcome addition to the main machine. Manufactured by W. F. Hoffmann, Denmark, the sole agent for the U.K. is Mr. B. J. Hamlin, 50 Charing Cross, London, S.W.1.

IT is now generally recognized that one of the important factors contributing to high-quality injection-moulding and extrusion production is the pre-drying and pre-heating of the particular material in use. It is doubtful, however, whether even yet the full implications of these treatments are known as widely as they should be. In some quarters there is undoubtedly the feeling that pre-drying is more of a refinement than an absolute necessity. It seems fairly certain that at least a good percentage of the indifferent end results sometimes obtained are directly due to either the unsuspected presence of moisture or alternatively to irregular temperature immediately prior to the material going through the machine.

The range of injection-moulding and extrusion materials has widened very considerably both during and since the late war, and whereas some of these materials are capable of taking up fair quantities of moisture either during transit or perhaps during storage, other materials whilst not necessarily absorbing moisture nevertheless are affected by atmospheric conditions to a greater or lesser degree, and consequently require special treatment if the best results are to be obtained.

A considerable amount of research work on this particular subject has been carried out for some years, and two years or so ago, Wilh. F. Hoffmann and Co., of Copenhagen, Denmark, brought on to the market an entirely new design of machine described as the Continator, a combined pre-dryer and pre-heater, which has proved itself to be an extremely efficient and economical adjunct to injection-moulding and extrusion plant generally.

The Continator pre-dryer and pre-heater consists essentially of an external housing which incorporates the control panel and air inlet with fine wire-mesh filter, removable hopper, reduction flange with slide gate, blower housing with motor, heater panel with relay, thermostat, thermometer, heating elements, change-over switch and pilot lamps, and double air-regulating valve with dust filter. An alternative form of filter, known as the Moist-Off, is also available for use in conditions where the normal air supply is unduly humid. This is a silica gel filter, incorporating the gel container, connecting rubber-tube to the Continator, mounting brackets and connecting stud.

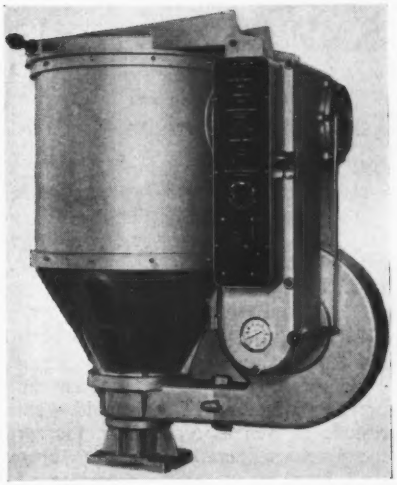
The Continator is specifically designed for mounting direct on to the machine with which it is to be used. The essential features are:—

(a) By adequate pre-heating, output per moulding machine is increased by means of higher moulding cycles. The quality of mouldings and extrusions is improved by the drying action of the unit.

(b) The moulding or extrusion material is filled directly into the Continator. Type 101/25, as an indication, will contain approximately 1 cwt. of cellulose acetate. The hopper is fitted with a magnetic separator.

(c) The heater control effectively regulates the internal temperature according to the rate at which the moulding material is discharged into the injection machine or extruder.

(d) The double air-regulating valve admits fresh air into the chamber where it is heated to the required temperature, and is then passed through the moulding material,



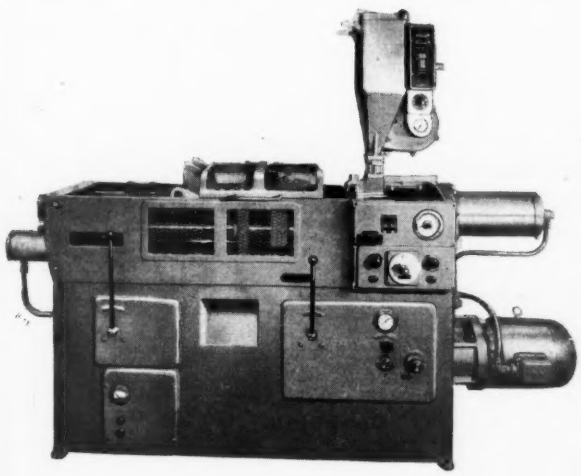
thereby giving the latter a uniform temperature throughout. This used air is then automatically delivered to the exit aperture. The air-control can be adjusted to give free exit to all the air taken into the machine, or alternatively to contain this heated air for whatever period of time is required.

(e) If the Continator is required for pre-heating only as distinct from pre-drying and pre-heating, then the air-regulating valve is kept fully closed so that the contained air is continually circulating in the heating chamber.

(f) As a complete unit of small dimensions, capable of being mounted directly on to the moulding machine in place of the usual hopper, the machine takes up no additional space.

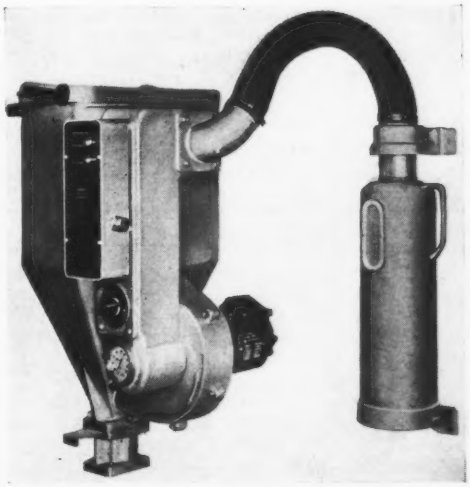
There are two standard types of machine available. The smaller one, No. 100/5, is adequate for all types of injection machines up to 4-oz capacity, and the larger type, No. 101/25, is adequate for machines of up to 16-oz. capacity.

The Continator has proved satisfactory for the pre-heating and pre-drying of cellulose acetate, acetate-butyrate, p.v.c., etc., and for the pre-heating of polystyrene, polythene, polymethyl methacrylate and polyamides.



(Left) S.H.S. Windsor injection machine, with continator type 100/5 mounted in position.

(Right) Unit fitted with silica-gel filter.



Thermal Degradation of Polymers During Moulding

By H. L. FRISCH and V. T. STANNETT

This is the first part of an article published in the January, 1954, issue of the "Journal of the Society of Plastics Engineers," U.S.A., and reprinted by arrangement with the Society. *Dr. H. L. Frisch is a member of the Dept. of Physics, Syracuse University, and Dr. V. T. Stannett of the State University of New York.*

IN the usual moulding practice, a part of the charge in the cylinder consists of material heated in the course of the previous operation of the mould. This material consists of residue as well as scrap from the sprues, and the like, of the previous operation cycle (an operation cycle being the time between successive chargings of the cylinder). The material is heated in the course of the operation of the mould and will thus be subject to some thermal degradation. Since a fraction of the material is used repeatedly it is quite to the point to ask how much of the charge of the cylinder say after the n^{th} operation cycle (heating) has been degraded and to what extent. The extent of degradation may critically affect properties of the moulded product, as for example the colour and mechanical strength.

Let M be the total mass of material in the cylinder equal to the mass of the moulding plus the mass of the residue. Let [f = (i, n)] be the mass of material heated exactly i times after a total of n operations (heatings) in the cylinder before the start of the n + 1st heating. The charge in the cylinder consists of a mass qM of residue left over from the previous heating plus the mass p (1-q) M of the scrap from the previous moulding plus a mass of (1-q) (1-p) M of fresh unheated "virgin" material added to the pot to make the mass of the charge M, i.e.,

$$\underset{\text{residue}}{qM} + \underset{\text{scrap}}{P(1-q)M} + \underset{\text{"virgin"}}{(1-p)(1-q)M} = \underset{=\text{charge}}{M}$$

Now from the definitions given:

$$M=\sum_{i=o}^{n} f(i,n)$$

with f (o , n) = (1-p) (1-q) M for all n.
Employing weight fractions rather than the masses themselves we can rewrite this letting
u (i , n) = f (i , n) / M,

$$1=\sum_{i=o}^{n} u(i,n)=(1-p)(1-q)+\sum_{i=1}^{n} u(i,n)$$

At the start of each operation the ratio of heated mass to unheated virgin mass is as
-pq + (p + q) : (1-p) (1-q).

Table I. Composition of Cylinder.

n	u(0,n)	u(1,n)	u(2,n)	u(3,n)	..	u(i,n)	..	u(n,n)	Sigma (from i = o to i = n) of u(i,n)
0	1	0	0	0	..	0	..	u(o,n)	1
1	1-a	a	0	0	..	0	..	u(1,1)	1
2	1-a	a(1-a)	a^2	0	..	0	..	u(2,2)	1
3	1-a	a(1-a)	$a^2(1-a)$	a^3	..	0	..	u(3,3)	1
i-1	1-a	a(1-a)	$a^2(1-a)$	$a^3(1-a)$	..	0	..	u(i-1,i-1)	1
i	1-a	a(1-a)	$a^2(1-a)$	$a^3(1-a)$	..	a^i	..	u(i,i)	1
n	1-a	a(1-a)	$a^2(1-a)$	$a^3(1-a)$	..	$a^i(1-a)$	..	u(n,n)	1

Now we have from the make-up of the charge before the n + 1st operation
f (1 , n) = q f (o , n-1) + p (1-q) f (o , n-1)
Since once heated material can only arise as a result of heating "virgin" material of the previous cycle we may divide by M and write
u (1 , n) = (q + p (1-q)) u (o , n-1)
Similarly for twice heated material we obtain the relation
u (2 , n) = (q + p (1-q)) u (1, n-1), etc.
and in general for values of i greater than zero and less than or equal to n,
u (i , n) = (q + p (1-q)) u (i-1 , n-1)
= a u (i-1 , n-1)
where a = (q + p (1-q)). Note that a lies between zero and one,
a = 1 if and only if q = 1.
This differential equation has to be solved under the conditions that
u (o , n) = (1-p) (1-q) = 1 - a , n greater than o and

$$\sum_{i=o}^{n} u(i,n)=1$$

The solution of this differential equation is
u (i , n) = a^i (1 - a) for i = o, 1, . . . , n - 1.
u (i , n) = a^n for i = n.
This can be readily seen from Table I.

Using this solution we can find for example the fraction of material in the pot which has been heated at least s times after a total of n heatings and just before the n + 1st, v(s,n), i.e.

$$v(s,n)=\sum_{i=s}^{n} u(i,n)=a^s$$

This is again readily seen from Table I.

We can now ask what is H (n); that is, the mean number of heatings of a given aliquot of a cylinder that has undergone a total of n moulding cycles and is just before its n + 1st moulding?

By definition

$$H(n)=\frac{\sum_{i=o}^{n} iu(i,n)}{\sum_{i=o}^{n} u(i,n)}=\frac{a}{1+a}\left(1-a^n\right)$$

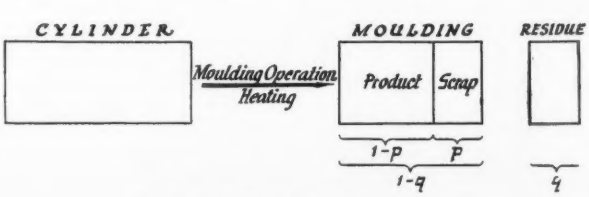


Fig. 1. Illustration of mathematical terms.

Since a lies between zero and one, H (n) for large n approaches a/(1 + a), i.e.
the limit approached by H (n) as n approaches infinity is a/ (1 + a).

Consider now some physical property of the moulding material which changes as a function of the heating time t(i) = i t where t is the duration of a heating (moulding) operation. Such a property is the fraction of material thermally degraded, D(t (i)) = D(it).

For example the fraction of thermally degraded i-fold heating material which has undergone a total of n operating cycles is D(i t) u (i, n). Thus the total fraction of material thermally degraded in the cylinder satisfies the equation.

$$Z_n = \sum_{i=0}^{n} D(i\bar{t})\, u(i,n)$$

We will consider several kinetic possibilities for this thermal degradation:

(a) Zero order kinetics

In this case

$$\frac{d}{dt}\,\frac{D(t(i))}{(i)} = k_0$$

which on integration gives

$$D(t(i)) = k_0\, t(i) = k_0 i t.$$

Thus

$$Z_n = \sum_{i=0}^{n} k_0 \bar{t}\, i\, u(i,n) = k_0 \bar{t} H(n) = k_0 \bar{t}\,\frac{a}{1+a}\left(1-a^n\right)$$

As n increases Zn approaches the limiting value

$$Z_{n\to\infty} = k_0 \bar{t}\,\frac{a}{1+a}$$

(b) First order kinetics

In this case

$$\frac{-d}{dt}\,\frac{D(t(i))}{(i)} = -k_1\left[1-D(t(i))\right]$$

which on integration gives

$$D(t(i)) = 1-e^{-k_1 t(i)} = 1-\left(e^{-k_1\bar{t}}\right)^i$$

Thus

$$Z_n = \sum_{i=0}^{n}\left[1-\left(e^{-k_1\bar{t}}\right)^i\right]_{u(i,n)} = 1-(1-a)\left[\frac{1-e^{-k_1\bar{t}\,n_a n}}{1-e^{-k_1\bar{t}\,a}}\right] - e^{-k_1\bar{t}\,n_a n}$$

As n increases Zn approaches the limiting value

$$Z_n = 1-\frac{1-a}{1-e^{-k\bar{t}_a}}$$

This illustrates how Zn can be calculated once D(it) is known. In the case of polystyrene it is known that the kinetics of thermal degradation in vacuum follow a rate law intermediate between first and zeroth order, while for polyethylene the overall rate appears to be first order.[1] In the actual moulding operation these rate laws would probably be modified in particular since air is not excluded during the operation.

In conclusion it has been shown that the amount of degraded material in the charge is asymptotically a function only of a the fraction of previously heated material and the kinetic rate law of the thermal degradation. The extent of degradation has been found for the case of first and zeroth order kinetics. In Part II of this paper we will report the findings of an experimental study of this problem which is now in progress. We are indebted to Mr. M. D. Curwen, editor of *Plastics*, who suggested this problem.

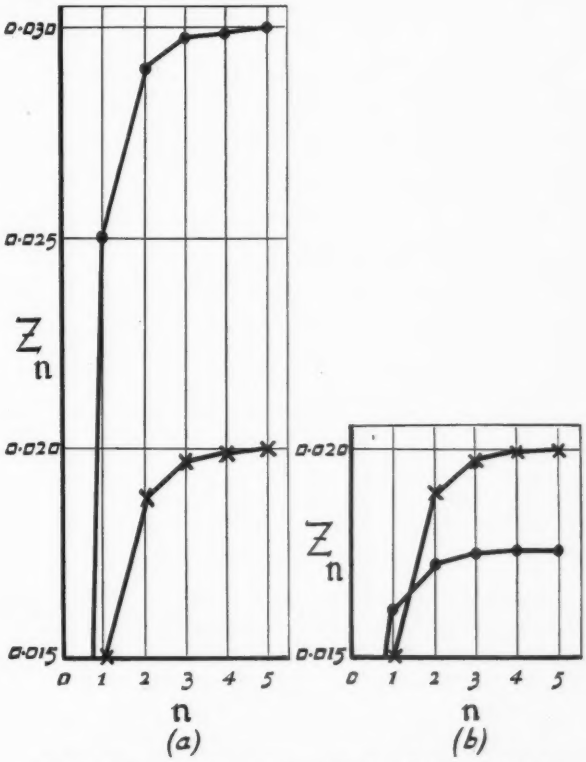


Fig. 2. The total fraction of thermally degraded material in the cylinder Zn as a function of the total number of heatings n ; x-lines are zeroth order kinetics; dot lines are first order kinetics:

(a) $a = 0.25$, $k_0 t = k_1 t = 0.1$;
(b) $a = 0.25$, $k_0 t = k_1 t = 1$.

Acheson Dispersing Service

A year ago Acheson Colloids, Ltd., the well-known manufacturers of colloidal dispersions of graphite, carbon and other materials, launched a dispersed pigments division to deal with increasing requests from industry for high-grade dispersions of pigments and other finely divided solids. In 1953 the division, which has its factory at Slough, Bucks, has experienced unusual success in what is something of a pioneer idea in Britain. It has been customary for makers of leathercloth, unsupported p.v.c. sheeting, and undertakings who need colours, to disperse their own pigments in plasticizers and other media. With 50 years' experience in dispersing and stabilizing solids it was logical that Acheson's should put that knowledge at the disposal of the plastics, paint and associated industries.

In consequence, their plant at Slough, designed to disperse pigments in all media, has been working to capacity, for a large number of users of dispersed colours. New ideas have been adopted and, using careful laboratory control, high standards have been achieved.

During 1953 undertakings in various parts of industry called on Acheson's to prepare stabilized dispersions of carbon blacks, titanium dioxide, mineral and organic colours of every kind in media ranging from straight plasticizers, through treated oils, resins to simpler carriers such as alcohols, ketones, hydrocarbons and water.

Industry is finding that dispersing colours is a dusty job, and withal, a specialized technique, if quality and economy is to be considered. It is in the fulfilment of that need that the dispersed pigments division of Acheson Colloids, Ltd., 18 Pall Mall London, S.W.1, has found itself very busy in planning extensions for 1954.

Machines for the Industry

NEW PECO INJECTION MACHINE

With the co-operation of the Projectile and Engineering Co. Ltd., the following notes and illustrations have been prepared on the 4/6 oz. injection moulding machine. The components numbered in the text are clearly shown in the drawing which appears on the page opposite. Below the drawing is also published a key.

THIS machine is the result of a combination of expert design and wide experience in the field of injection moulding. All the well-tried characteristics of existing PECO machines have been included, as well as many novel features developed by the company's experimental department, which is working continuously to develop further the mechanical, hydraulic and thermal efficiency of the machines.

The main base, a solid welded-steel-plate structure of box construction, supports the platen assembly and the injection unit, in addition to housing the 100-gallon tank[37] and the Vickers two-stage pump.[41] The electrical and heater control equipment is mounted on a hinged panel,[29] also housed in the front of the base at the opposite end to the oil tank, thus eliminating any possibility of damage by oil, and by virtue of this method of mounting ensuring easy access for maintenance.

The mould-locking and platen assembly includes a fully balanced quick-acting toggle mechanism[3] fitted with hardened and ground toggle pins operating in hardened and ground sleeves. The movement is positioned to spread the locking force over as wide an area as possible, thus ensuring great rigidity and sturdiness under operating conditions, when a locking force of 150 tons is developed. As well as effecting a high locking force, the toggle mechanism admits a large opening stroke, thus enabling deep components to be moulded and extracted easily. Improved hydraulic cushioning of the closing ram ensures very fast mould closing and mould opening. Four high-tensile steel tie bars[42] of 3½-in. diameter are widely spaced to accommodate large moulds, one of the bars being easily removed if necessary to facilitate setting-up.

The thrust plate[2] is located in T-section keys, which allow it to move slightly longitudinally in order to accommodate the elongation of the tie bars. The stationary platen,[13] on the other hand, is rigidly keyed to the base.

Both the moving platen[11] and the moving-platen back plate[6] are guided by phosphor-bronze bushes,[9] operating on the four tie bars, and their weight is taken on cast-iron bearing shoes[4] which slide on hard, chromium-plated rails. These slides enable heavy moulds to be easily accommodated on the tail stock platen and help to eliminate any tendency of the platen to tip.

Both toggle assembly and bearing plates are automatically lubricated by a Tecalemit pump with metering valves to all points. Central screw, die height adjustment[8] is incorporated, enabling mould setting to be achieved in the simplest and most definite manner. Four ejector rods[7] are provided, which may be used together or in pairs. Alternatively for central ejection, one pair may be used in conjunction with a diagonal transverse ejector bar.[10] The ejector stroke is adjusted by a cranked handle from the end of the machine. The whole of the closing end is enclosed by steel covers.[5]

The hydraulic injection cylinder,[22] hopper-feed mechanism,[19] heating chamber[16] and hydraulic push-off mechanism are mounted on a heavy cradle,[21] which slides on chromium-plated ways[24] on the base. This fully floating mounting eliminates the hobbing of the nozzle into the mould. Adjustment of the injection unit with respect to the sprue bush is entirely automatic and is performed by the two hydraulic cylinders[18] and shown in the diagram. The length of the sprue-break movement can be varied by adjusting a limit-switch striker,[28] but if sprue break is not required the nozzle can be held in contact with the sprue bush. Furthermore, the whole of the injection unit may be withdrawn by depressing a push-button,[32] thus permitting easy access to the sprue bush and facilitating scavenging of the heating chamber and use of moulds featuring the "Italian" sprue.

The hydraulic injection cylinder and the hold-on cylinders[18] are fed by a telescopic system,[25] which may be seen in the diagram underneath the injection unit.

The hopper-feed mechanism[19] is of the self-compensating type, is fully adjustable by means of the stop nuts[20] and is operated by the main hydraulic ram[23] through a shear-pin safety device, thus protecting the unit from excess load.

Many years' research and development have gone into the design of the heating chamber[16] and the spreader,[15] which form the most vital part of any injection-moulding machine. By carefully selecting the best combination of the many variables involved, PECO engineers have ensured a constant average temperature of the material for high plasticizing rates, and the most efficient use of the heat energy available. Careful consideration of the flow characteristics of the spreader and internal chamber profile have reduced the pressure loss through the chamber to the minimum and facilitates quick change-over of materials and colours.

A series of band heaters[17] are employed to heat the chamber, these heaters being divided into two zones, each zone being independently controlled by an Ether-Wheelco temperature controller.[26] Heater replacements are facilitated by the provision of a junction box, into which the heater lead plugs are inserted, thus obviating the necessity for rewiring. It is also possible to check the continuity of heaters without disconnecting them. The temperature controllers permit accurate control over a wide range and will maintain temperatures to within 3° C.

During the investigations into heating chamber design, the behaviour of a wide

(*Continued on page 98*)

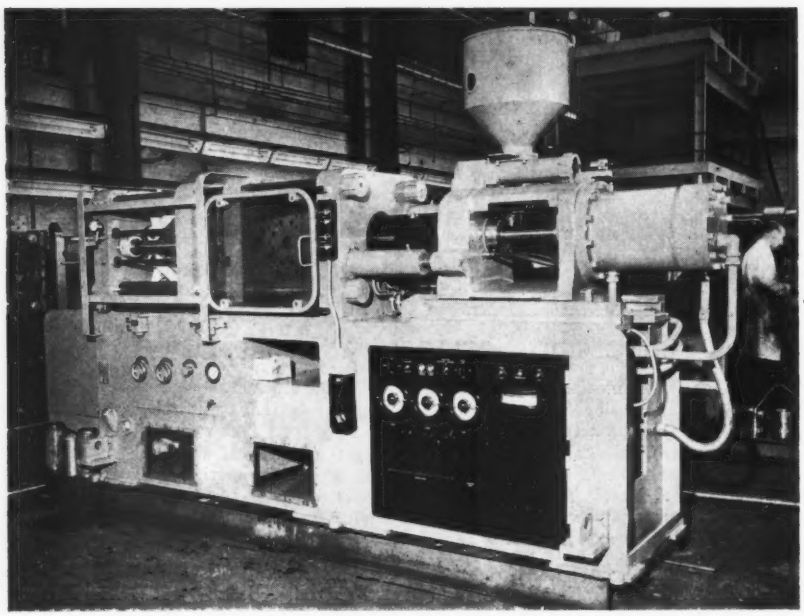
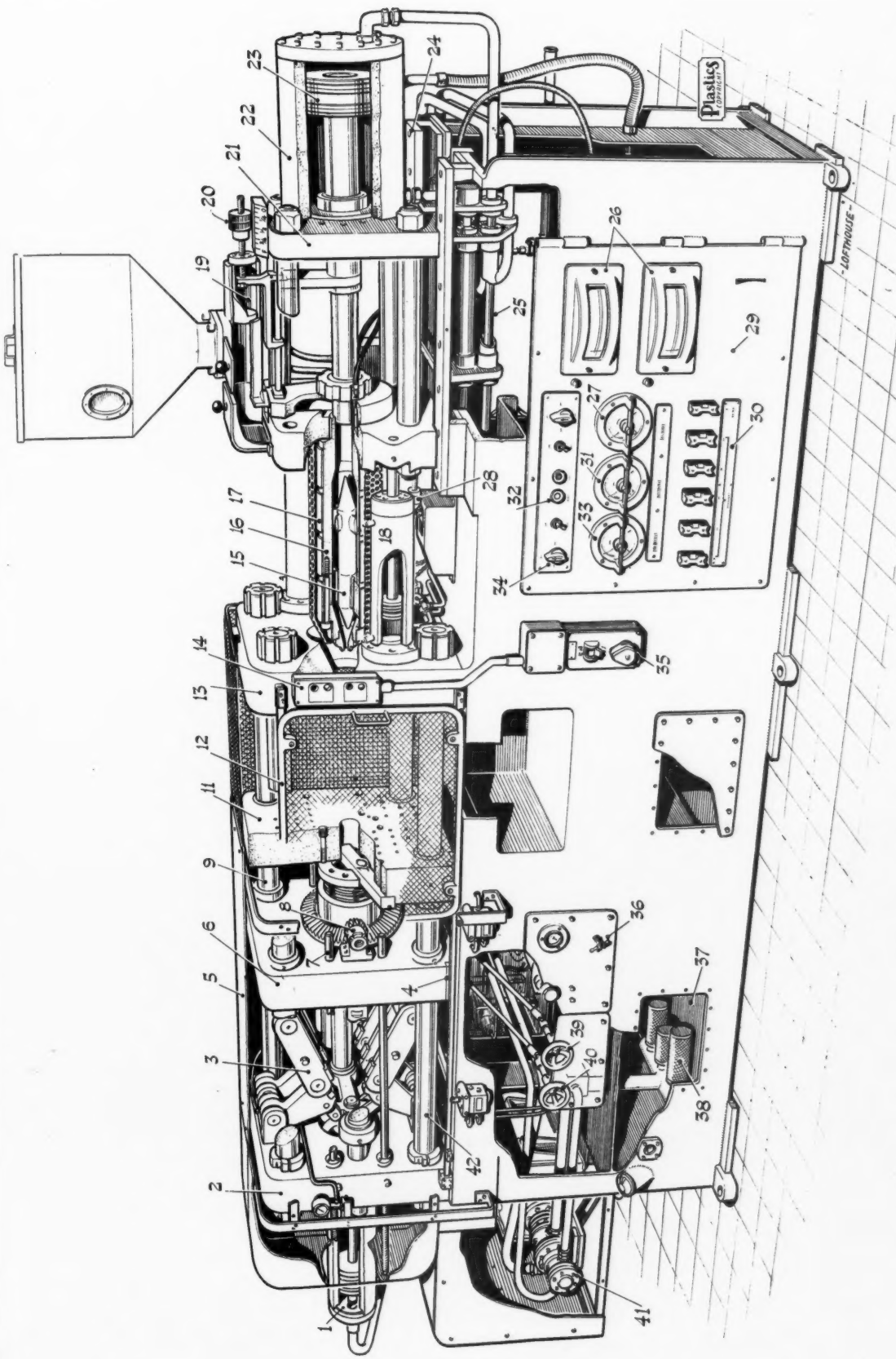


Fig. 1.—General view of operating side of machine, obtained during assembly. Certain components, formerly cast, are now machined.



PECO 4/6 OZ. INJECTION MOULDING MACHINE: KEY TO DRAWING ABOVE:— 1.—Toggle operating cylinder. 2.—Thrust plate. 3.—Toggle mechanism. 4.—Bearing shoe. 5.—Cover. 6.—Moving-platen back plate. 7.—Ejector rods. 8.—Die-height adjustment gears. 9.—Platen bushes. 10.—Ejector bar. 11.—Moving platen. 12.—Safety gate. 13.—Stationary platen. 14.—Starting and ejection buttons. 15.—Spreader. 16.—Heating chamber. 17.—Band heaters. 18.—Hold-on cylinder. 19.—Hopper-feed mechanism. 20.—Stop nuts. 21.—Cradle. 22.—Injection cylinder. 23.—Injection ratio timer. 24.—Cradle ways. 25.—Telescopic system. 26.—Ether-Wheelco temperature controllers. 27.—Cure timer. 28.—Switch striker. 29.—Electrical panel. 30.—Fuses. 31.—Boost timer. 32.—Withdrawing button. 33.—Injection pressure-gauge restrictor. 37.—Oil tank. 38.—Filters. 39.—Injection speed control. 40.—Die-lock speed control. 41.—Hydraulic pump. 42.—Tie bar.

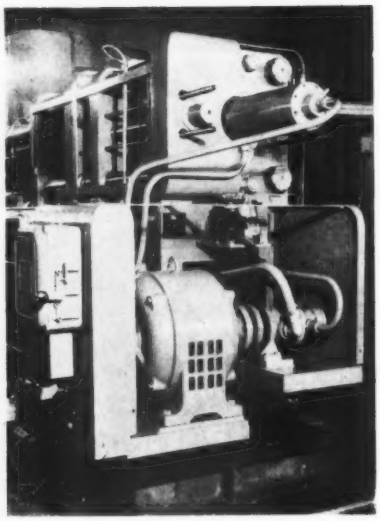


Fig. 2.—(Above) Detail of motor and hydraulic pump.

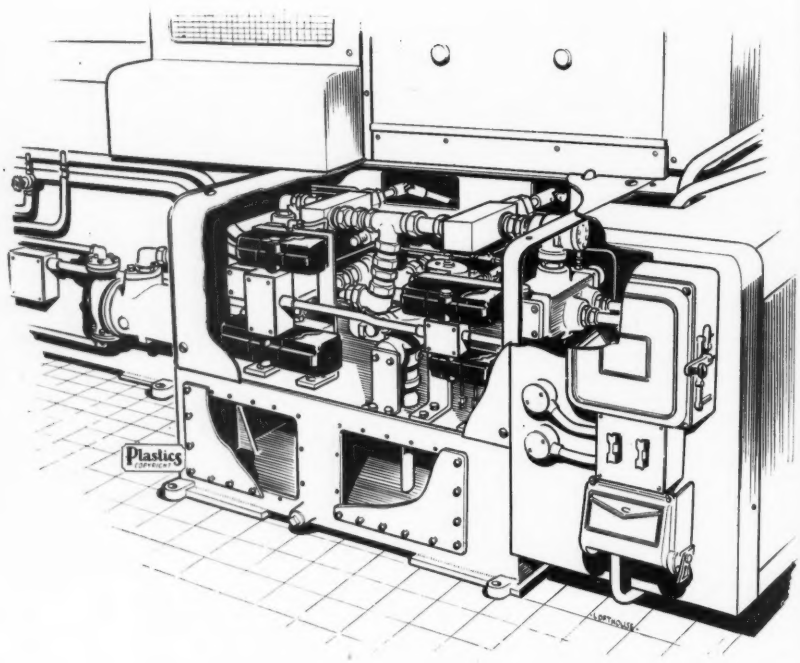


Fig. 3.—(Right) The hydraulic system, not shown on drawing on previous page.

range of materials was studied, and this led to the development of two heating chambers. The plasticizing unit A gives a 4½-oz. shot and a maximum injection pressure of 20,000 p.s.i. is offered for use with some of the harder materials, such as methyl methacrylate where high injection pressures are necessary. The B unit, which is capable of shooting 6 oz., caters for the great majority of mouldings in most of the commercial thermoplastic materials.

A new feature of this machine is the ram advance control, which allows the ram to move forward to a preset position during the cure period and allows rapid injection when the next cycle begins.

The hydraulic gear is mounted on a platform at the rear of the machine and is shown in Fig. 3. The whole of the equipment is protected by easily removable steel covers, thus facilitating easy access for maintenance purposes.

For fully automatic operation, the cycle is started by depressing button[14] on the stationary platen.[13] The moving platen then moves forward at high speed and as the mould faces come together locks at high pressure. A very sensitive safety device is incorporated, to ensure that the platens cannot close under high pressure if a foreign body is trapped between the mould faces, thus protecting the mould from damage. When the mould has locked, the injection ram is automatically selected forward, the "holding-on" period of the ram being controlled by the injection timer.[33] The actual time period during which maximum injection pressure is held is controlled by a boost timer and a cure timer governs the period between the initial retraction of the injection ram and the opening of the die. A further process timer is incorporated to provide a delay before the machine commences another cycle and enables the moulding to fall away from the mould before the platen closes again. It is clear that with this flexibility of control, wide variation of the pressure volume temperature relationship in the mould may be accomplished, thus catering for the different conditions required by individual moulds.

Semi-automatic operation is selected by rotation of switch,[34] and using this system of control it is merely necessary for the operator to depress a push-button to initiate each successive machine cycle, the stages of each cycle being entirely automatic.

To change the machine from automatic to hand operation, it is merely necessary to turn the selector switch[34] and to operate the mould-closing and opening buttons[14] and the injection forward and return buttons in the correct sequence.

A sliding safety gate[12] of tubular-steel construction is provided which is hydraulically interlocked with the main control gear. Should the gate be opened during a moulding cycle, the moving platen is returned to the open position and the rest of the machine rendered inoperative. When the gate is fully open the hydraulic circuit is unloaded. thus ensuring that there is no overheating of the hydraulic oil.

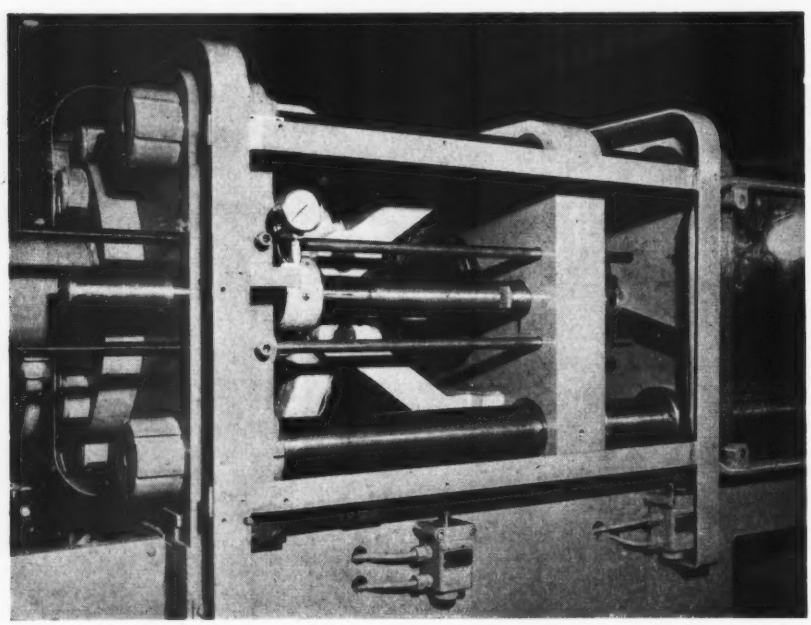


Fig. 4.—Close-up view of toggle assembly.

Production by Vacuum Forming

By P. A. SAUTER

Vacuum forming is one of a number of methods of fabricating from thermoplastic sheet. Mr. Sauter, of Hydro-Chemie, Switzerland, has been concerned with the development of the Formvac machine, designed to make vacuum forming a production technique. This article, condensed from a paper presented by the author to the Swedish Plastics Federation last year, discusses the factors involved, including moulds, moulding materials, and equipment.

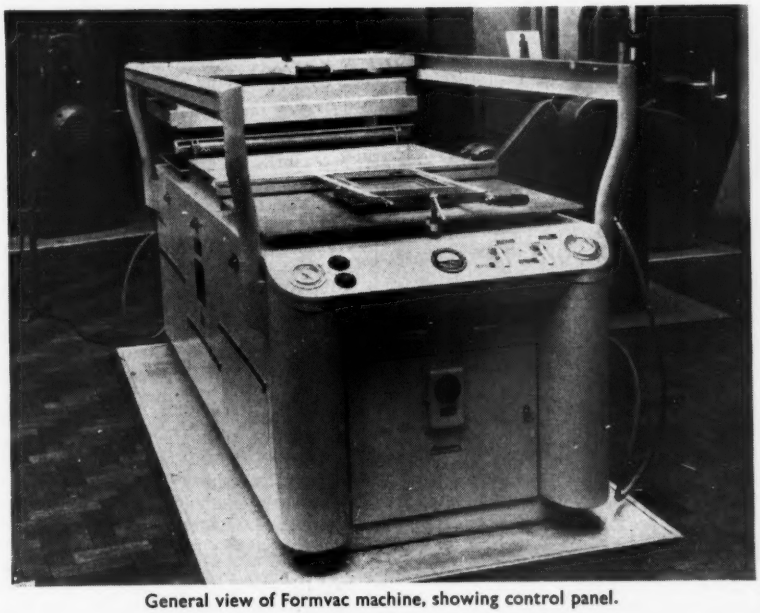
THE process known as vacuum forming uses as raw materials practically all compositions of thermoplastic sheet, in a wide range of thicknesses. Among materials which can be moulded by this process may be mentioned: rigid and plasticized vinyls, polystyrene, styrene alloys and copolymers, methyl methacrylate, polyethylene, cellulose acetate, nitrate, ethyl cellulose and cellulose aceto-butyrate.

The vacuum-forming process involves the heating of thermoplastic sheet to a temperature at which atmospheric pressure will cause it to draw into, over, or around a mould which may be positive or negative in design. This is effected by clamping the sheet in such a way that it becomes an air-tight membrane over an enclosed space or box. This box may constitute the mould in its entirety, and thus a negative or female mould; alternatively, it may contain the mould, giving a positive or male mould. The box or space must be connected, by means of suitably located perforations, with a vacuum tank, in order that the air between the sheet and its mould surface may be evacuated.

The heat-softening is accomplished by bringing a radiant surface heater into position about 1 in. to 2 in. above the surface of the thermoplastic sheet. This heater must distribute heat with utmost uniformity in order not to set up undesirable stresses and strains which would detract from accurate reproduction of mould details. Furthermore, in the interest of fast, economical production of plastic articles, the heater must be capable of softening the sheet material as rapidly as possible.

In certain cases, accurate reproduction of mould surface details is best obtained by means of split-second evacuation of the air between the heat-softened sheet and the mould surface. This may be readily understood in the case of soft vinyls which are to be finely embossed; best results are obtained here if the hot, pliable sheet is projected with some force against the mould surface. Similarly, rapid air evacuation is desirable in the moulding of all types of thin-gauge sheet which are required to assume intricate patterns. Meanwhile, in other cases, a slower evacuation of air—and eventually a "phased" air-evacuation process—may be desirable. This would apply, for example, to thick acrylic and rigid vinyl sheet materials which, if deep-drawn too abruptly, would not have sufficient time to follow their natural-flow behaviour, thus resulting in exaggeratedly thin areas at points of maximum curvature, eventually leading to complete rupture of the sheet.

Whereas the other, known methods of fabricating articles from thermoplastic sheet generally involve preheating the sheet and then transferring it to the mould area, where the necessary pressure is then applied, vacuum forming offers the advantage of heating the material at the mould area, thus making it possible to shape the material at absolutely uniform temperature—which makes for accurate moulding—and with minimum labour and loss of time—denoting economical moulding. By the same token, vacuum forming enables extremely thin-gauge sheet material to be handled—material which would otherwise cool down far too rapidly to allow for it to be heated in one location and then transferred to another location for shaping.

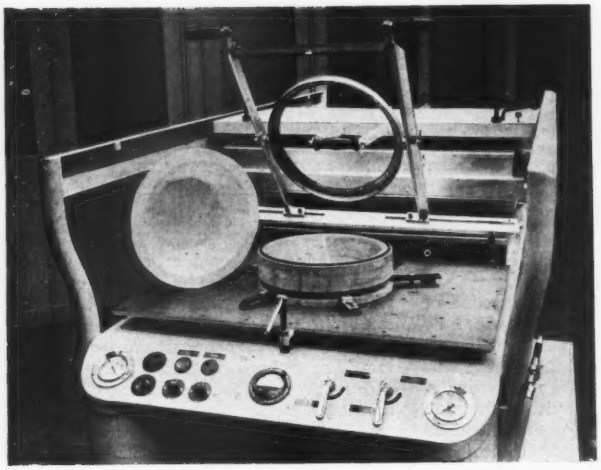


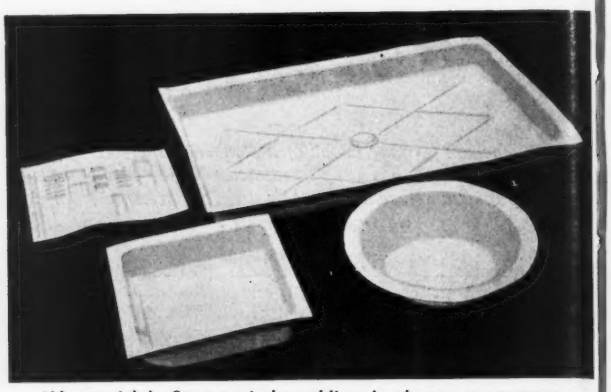
General view of Formvac machine, showing control panel.

Probably the greatest attraction of vacuum forming for the plastics fabricator stems from the fact that the maximum pressure involved is that of the atmosphere—signifying that the moulds are subjected to a minimum of wear and tear, and may consequently be made from such low-cost materials as cement, plaster, wood, cast resin and light alloy.

The raw materials used in vacuum forming fall into two distinct categories: soft and rigid thermoplastic sheet. When speaking of soft sheet, we have in mind essentially plasticized polyvinyl chloride or vinyl copolymer film and sheet. This type of material may be embossed with surprising accuracy by vacuum deep drawing. Moulds can be made by several methods. Metal spraying, direct on to models of linen or leather, is one of the most attractive means of making moulds rapidly and accurately. Another means is to make a plaster or cement cast of the model. This involves very low raw-material costs, but the moulds require a few days for hardening; also, they are less durable than the metal-sprayed types. In both cases, the necessary perforations in the mould may be obtained by previously inserting fine pins into the model, usually one to about every $\frac{1}{2}$ in., located at the highest spots in the relief pattern of the model One of the technical advantages of vacuum deep drawing over calendering as a means of embossing soft vinyl is the ability to obtain undercut relief patterns—particularly attractive in the reproduction of certain intricate embroideries. The commercial attraction, of course, is the possibility of obtaining appealing designs at mould costs which appear non-existent when compared with the cost of calender embossing rolls. This means that all embossed plastic sheet need not necessarily be of mass-produced design, but may now be fabricated economically in small quantities having exclusive patterns. Moreover, low-cost vacuum embossing, combined with the possibility of preprinting the sheet prior to forming it, gives scope to fabricators of novelties and articles for the fashion trade.

Vacuum forming enables rigid sheet to be moulded into an unlimited variety of shapes and dimensions, from tiny pillboxes to large suitcases and refrigerator door liners. Male moulds are suggested for deep draws using thin-gauge sheet, while female moulds allow of more accurate reproduction of detail. Wood and plaster are among the most used materials for large articles of simple design, whereas light alloys of the softer variety are





(Above, right) Some typical mouldings by the vacuum process. The smallest unit shown measures some 10 in. by 22 in.

(Left) One of the two platens of the machine, each having a separate control panel. The clamping device is shown raised.

most suitable for smaller products, such as packaging containers requiring close tolerances.

It is in connection with rigid articles that the economical advantages of vacuum forming over conventional moulding become acutely apparent—and notably in the case of large pieces. The ratio of mould costs becomes almost absurd when one considers the probable cost of an injection mould for a refrigerator door liner, compared to that of the simple wooden mould to produce a product of equal dimensions by vacuum forming.

Not only are the moulds inexpensive, but they can be made rapidly—in a matter of days, and sometimes hours. And the moulder can generally do the work himself and thus become independent of outside toolmakers.

Vacuum moulding may, therefore, be described as a plastics conversion technique which is suited to both long and short production runs.

It is true that thermoplastic sheet material may cost up to twice as much as moulding pellets of the same composition. This price difference is offset to a certain extent by the ability to obtain, by vacuum forming, wall thicknesses down to a fifth or less of those obtainable by injection moulding. And since sheet material is less subject to stress than moulded pellets, these thin walls can be successfully applied. Thin walls can be ribbed where greater rigidity is required.

Three-dimensional articles in several colours may be produced at very low cost by vacuum forming because the sheet may be preprinted "in the flat"—either by lithography or silk-screening—prior to being deep drawn. As examples of this type of product might be mentioned relief maps, advertising displays, doll faces and carnival masks. These are typical products which could not be profitably made by any other method but vacuum forming.

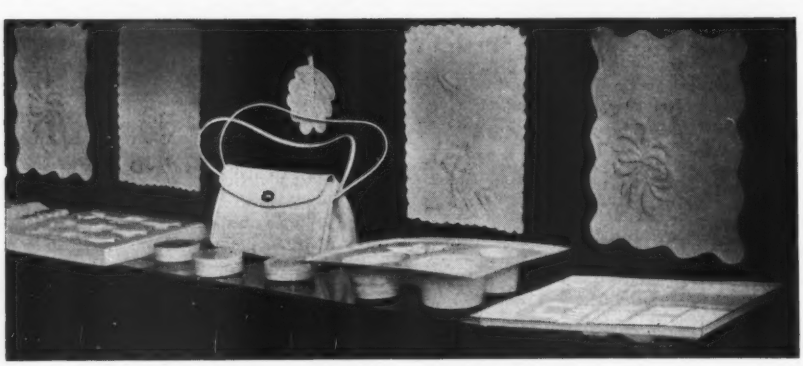
The most important element of the Formvac machine is the heater unit, which can be preset on the indicating pyrometer to any temperature from 200° to 750° F. On this particular model of machine, the effective heating area measures 24 in. by 36 in., and throughout this area the heat is radiated down towards the mould plate with utmost uniformity. The heater slides on rails to serve two mould plates, thus permitting uninterrupted manufacture because, while one operator is removing a moulded article, the other operator has loaded the mould at the other end and is preparing to pull the heater over it.

Each of the mould plates presents a total effective moulding area of 24 in. by 36 in., with a certain amount of overlap being provided at each edge to compensate for clamping frames and to offset ambient cooling effects. Each mould plate has numerous openings to enable one or several moulds to be connected with the vacuum tank inside the machine. Thus the total moulding area may be devoted to one large mould, or to several smaller moulds. In the assembly illustrated here, full use is not made of the total available area.

The pump and tanks are dimensioned so as to allow of a maximum depth of draw of 14 in. over the entire moulding area of 24 in. by 36 in.

Vacuum-forming moulds actually take the shape of a double box, the shallow cavity at the base being for air distribution. The edge around this shallow cavity—thus the base of the mould—is generally fitted with a strip of sponge rubber, so that it can form an airtight seal against the mould plate. Another strip of sponge rubber runs around the top edge of the mould, so that the sheet may form an airtight joint when the clamping frame presses it against the mould. The clamping frame is held by a supporting frame which is hinged to the back of the mould plate, and which can be adjusted to handle any size of clamping frame. A roller spring in the hinge gives a gentle raising and lowering action, and a simple lever latch enables the frame to be locked rapidly and firmly in position, and readily unlocked and raised after the deep-drawing operation.

Once the mould is loaded, the heater is drawn over it and the vacuum activated as soon as the sheet is sufficiently pliable to be formed. The optimum heating cycle must be established by trial and error, but certain data are available for estimating this. It has generally been found that thermoplastic sheet materials require between 7 sec. and 12 sec. per 10-thou. thickness for heating and forming, whereby the heating cycles do not increase in direct rates with thickness, i.e., if a 10-thou. sheet of high-impact styrene requires a heating cycle of 8 sec., it does not necessarily follow that a 20-thou. sheet requires 16 sec.; as a matter of fact, in this particular case the thicker sheet would require only 12 sec. to 13 sec. Thermoplastic sheet articles, as regard heating cycle, seem to run approximately as follows: rigid copolymer vinyls, of the low-to-medium molecular weight types, heat up quicker than other materials, and are followed by polystyrene, high-impact styrene, cellulose aceto-butyrate, plasticized vinyl, high-molecular-weight rigid vinyl, cellulose acetate, polyethylene, methyl methacrylate. Meanwhile, it is not possible to lay down



Samples of vacuum formed articles. In the background are mouldings from soft vinyl sheet, formed over intricate embroideries.

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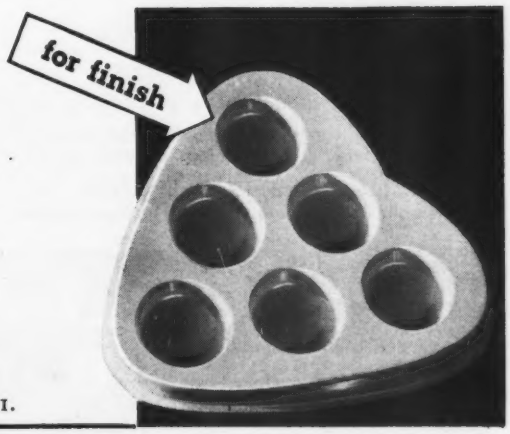

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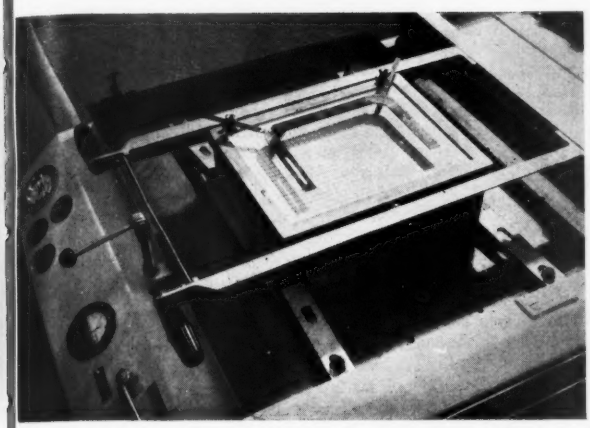

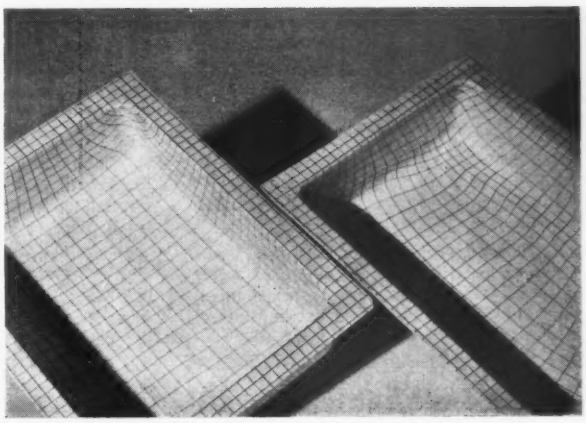

Shown above is a technique for overcoming excessive thinning of material at areas of maximum depth and curvature. Careful masking can prevent this problem arising, and test pieces are shown on the right.

hard-and-fast rules in so few words on optimum heating cycles: certain materials, depending on their structure, call for higher or lower temperature on the heater; this fact upsets the scheme of a table of heating cycles drawn up strictly in accordance with the thermal properties of the various materials.

To revert to the practical aspect of manufacturing, once a heating cycle has been established, this cycle can be preset on a timer clock which, upon completion of the cycle, activates the vacuum through solenoid valves. On this machine there is a timer clock for each mould plate, thus enabling two different cycles to be set up simultaneously.

A separate valve on each instrument panel enables the velocity of air evacuation to be regulated. As stated earlier, certain compositions of thick rigid sheet, notably acrylic and polyvinyl chloride, need to be formed relatively slowly in order to allow the plastic material to flow evenly into the areas of maximum curvature and depth. Just how slowly the vacuum should be applied is governed by the flow properties of the material. The method of determining the optimum vacuum pressure is essentially empirical; that is to say, by trial and error. On the other hand, thin sheets which have to follow intricate patterns, and soft vinyl which has to be finely embossed, call for extremely high vacuum pressure causing the hot sheet to hit the mould contours with some impact.

It is appropriate to emphasize at this point that, notwithstanding every precaution as regards vacuum velocity, very deeply drawn sheet material is bound to become thin at the areas of maximum depth and curvature. There is, however, a very simple means of fully overcoming this drawback. Take, for example, the case of a rectangular box 30 cm. wide, 40 cm. long and 15 cm. deep. Deep-drawn under normal circumstances, this box will probably have excessively weak edges and corners. The correction is made by masking the edge and corners areas during the heating operation, by means of a suitably shaped strip of metal held about 1 in. above the sheet. In this way the vulnerable areas are heated less and consequently flow less during the forming. These areas are very easy to locate in relation to the flat sheet. The method is first to draw 1-cm. squares over the entire flat sheet and then deep-draw it. The vulnerable areas are indicated by the squares which have undergone the greatest deformation. These are located in relation to the flat sheet by counting the lines from the edges. Likewise, the widths of these areas are determined by the number of squares in the deformation area. If the mask is fixed to the frame which clamps the sheet over the mould, it can be raised and lowered with the clamping frame and does not hinder production in any way.

Following the deep-drawing operation, simple depression of a hand lever causes compressed air to be passed through the vacuum openings, thus cooling the moulded sheet and facilitating its removal. Compressed air pistols, located at each mould plate, can also be used for cooling and removing intricate mouldings, although their main purpose is for cleaning the moulds.

On the machine shown here, an additional means of sheet temperature control is provided in that each entire mould plate may be raised and lowered pneumatically, thus varying the distance between the sheet and the heater surface. A calibrated dial before each operator enables the travel of the mould plate to be preset to the millimetre, and a different distance may be preset for each mould plate. This feature adds to the machine's versatility since it permits materials having widely different thermal characteristics to be worked simultaneously.

A question which invariably arises concerns the method of separating moulded articles from the base sheet; or rather, a fast, simple and inexpensive method of accomplishing this. Whereas all the conventional methods of sawing, shearing and stamping may be applied, preliminary experiments which we have conducted with heated metal stamps, hot wires and strips seem very promising. Not only is the cutting out accomplished rapidly and inexpensively, but the hot cutting instrument gives a well-finished edge to the moulded article. In certain cases, the mould may be designed so as to create a weak section where the piece needs to be separated, thus enabling the article to be snapped off. The method of separation will usually have to be adapted to the type of sheet used and the configuration of the moulded article. We can offer thoroughly satisfactory solutions to the majority of cutting-out problems and have no doubt that we are rapidly nearing solutions to every problem in this particular field.

To those who remark that vacuum forming, in conjunction with the Hydro-Chemie machine, appears to be deceptively simple, we would reply that it is indeed simple, and deceptive only if too direct a comparison is made with injection moulding. Vacuum forming will compete only to a very slight extent with injection moulding. Its major application will be in the manufacture of many entirely new types of article hitherto not made from plastics; and we feel confident that, in this role, it will soon rank alongside the older processes as one of the universally accepted methods of plastics fabrication.

The B.I.F., 1954

The Chemical Industry and the B.I.F.—Over recent years there has been a decline of interest among exhibitors in the Chemical Section of the B.I.F. at Olympia. As a result, the Association of British Chemical Manufacturers are giving thought to what should be the industry's future policy in regard to national exhibitions. Two committees have been set up—one to examine and report upon the feasibility of promoting separate specialized exhibitions for the industry; the other to review what form the industry's representation should take if it is decided to continue to take part in the B.I.F. either at Olympia or Birmingham. In the meantime, it has been decided to have an A.B.C.M. stand at Castle Bromwich, on which 20 of the leading chemical companies will have separate display units. There may be a closer affinity between the chemical industry and those industries which habitually exhibit at Birmingham than there is between the chemical industry and those which normally show at Olympia. It is hoped that the chemical industry's stand at Birmingham will enable members of the Association to assess the advantages of Birmingham as an exhibition centre.

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. The country of origin for Convention Applications is shown in parentheses. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 2s. 8d. each (including postage).

B.P. 700,062. Flat-tanged cutlery. A. Sanders. To: Sanders and Bowers, Ltd.

Rivetless design for a handle of methyl methacrylate.

B.P. 700,086. Palette. R. E. Carr.

Artist's palette made up of sheets some of which are synthetic resin sheets glued along the edges and on to a backing board of metal, wood or plastic.

B.P. 700,093. Machines for the manufacture of airtight packing bags. To: Cellophane S.A. (France).

B.P. 700,095. Educational apparatus. R. M. Dunn.

Parts, e.g., of plastic to build up letters and numerals.

B.P. 700,112. Embossing machines for producing printing plates. J. H. Gruver. To: Addressograph-Multigraph Corp.

Printing characters are formed one by one on a plastic printing plate of cellulose acetate. The plate is moved in position opposite a die cavity in a type head and pressure applied using a typewriter known as "Electromatic."

B.P. 700,118. Synthetic resin composition. To: Henkel and Cie. G.m.b.H. (Germany).

Polychlorinated hydroaromatic ketones are suitable for heat-hardenable compositions which are practically unlimitedly stable at high temperatures and in presence of liquids.

B.P. 700,122. Die-cutting plate for use in die-cutting operations in platen printing presses or high-speed cylinder printing presses. To: Schnellpressenfabrik A.G. Heidelberg (Germany).

The plate is formed of a thermosetting plastic material on a web of fabric.

B.P. 700,127. Non-refillable bottle closure. A. Whittam. To: John Haig and Co., Ltd.

B.P. 700,145. Marker for books, pamphlets and the like. M. E. Bishop.

B.P. 700,158. Jacketing compositions for electric cables. To: Standard Telephones and Cables, Ltd. (U.S.A.).

A homogeneous mixture of copolymers of vinyl chloride and vinyl acetate, copolymer of acrylonitrile and butadiene, and polyester of propylene glycol and sebacic acid as main ingredients.

B.P. 700,163. High-pressure resistant seals suitable for submarine cable repeater housings. E. W. Smith, R. W. Presswell. To: Submarine Cables, Ltd.

An annular throat is closed by a polythene body united with the metal by polyisobutylene which may be mixed with polystyrene.

B.P. 700,172. Treatment of polyacrylonitride. To: Farbenfabriken Bayer (U.S.A.).

The tensile strength when hot is increased by a treatment with ammonia or a polyamine, which also increases the capacity of being dyed.

B.P. 700,177. Coating metal-sheathed cables with plastic material. J. N. Dean. To: Telegraph Construction and Maintenance Co. Ltd.

The heated cable is passed through a vessel containing cold polythene powder.

B.P. 700,194. Flexible sheet material. R. J. Ashall. To: Fibreglass Ltd.

Ground covering for temporary aircraft landing strips of bonded glass fibres coated with polyvinyl chloride on both sides and an outer coating of bitumen.

B.P. 700,204. Vehicle electric lamp. A. D. Baker. To: Joseph Lucas (Industries) Ltd.

A plastic material may be used for body and transparent cover.

B.P. 700,219. Sausage. McD. W. Lamb (U.S.A.).

The paste is encased in a polythene film disintegrating at cooking temperature leaving no perceptible residue. Any residue is inert, non-toxic and edible.

B.P. 700,281. Toy. Cecil Coleman Ltd., R. S. Coleman.

Moulded halves of a body with interconnecting members.

B.P. 700,291. Spectacle frame. C. L. Curtet (Switzerland).

B.P. 700,294. Base plate carrying bristles for brushes. H. Mortimer.

B.P. 700,304. Voltaic cells. A. Linton, R. W. Lewis. To: Burndept Ltd.

Alkathene is used for a connector and cell receptacle rendered conductive by mixing the middle part of the shallow cup with finely divided carbon.

B.P. 700,348. Lamp shades. Waite and Son Ltd., P. W. Strutt.

The panels (cellulose acetate) are connected at one end of the rigid frame by a continuous flange part, at the other end by decorative braid.

B.P. 700,356. Polymeric materials and articles produced therefrom. W. E. F. Gates, H. A. Rigby. To: I.C.I. Ltd.

A sulphated long chain alcohol is incorporated to prevent the accumulation of electrostatic charges.

B.P. 700,366. New products having valuable plasticizing properties and plastic compositions formed therewith. J. R. Holker, Petrocarbon Ltd.

The products are ethylene, propylene and ethylene propylene glycol mono-naphtylmethyl ethers which may be used as plasticizers in vinyl or cellulose derivative compositions.

B.P. 700,442. Injection-moulding machine. R. Davidson, C. Butterworth.

A ram is slidable in a movable cylinder to eject a charge via a discharge nozzle. The cylinder is moved to sealing contact with a die box on each operative stroke of the ram. Ram and box holder are actuated by fluid pressure; the die box is automatically released on the return stroke of the ram.

B.P. 700,447. Suspender fasteners. A. Eilertsen.

B.P. 700,493. Piezo electric elements. L. R. Lovelock, W. R. Mason-Tulby. To: Standard Telephones and Cables Ltd.

In fixing synthetic piezo-electric crystal plates to an electric wire a cement is used made from thermosetting resin (Araldite, Epon).

B.P. 700,505. Sealing discs for the closure members of bottles, jars and other containers. Hyde Plastics Ltd., J. T. Hyde.

B.P. 700,507. Rotary brushes. J. M. Clark. Comm. from: A. M. and Wm. Clark.

The stock is a single casting made of injection-moulded ethyl cellulose or another light, water-impervious, non-sound conducting plastic.

B.P. 700,538. Packaging materials. To: Transport Package Co. (U.S.A.).

A composite tubular casing (for meat, ham, salami, wieners) of regenerated cellulose film coated with a moisture- and air-controlling material.

B.P. 700,545. Artificial teeth. R. Nussbaum.

A special design for molars and premolars made from an acrylic resin.

B.P. 700,608. Polymeric products derived from polyisocyanate-modified polyesters. To: Farbenfabriken Bayer (U.S.A.).

B.P. 700,609. Polymeric materials obtained from di-isocyanate-modified polyesters. To: Farbenfabriken Bayer (Germany).

B.P. 700,610. Synthetic elastic polymers obtained from di-isocyanate-modified polyesters. To: Farbenfabriken Bayer (Germany).

B.P. 700,611. Polymeric products derived from polyisocyanate-modified polyesters. To: Farbenfabriken Bayer (Germany).

B.P. 700,617. Production of mouldable or adhesive polyester compositions. To: Farbenfabriken Bayer (U.S.A.).

B.P. 700,619. Production of moisture-proof regenerated cellulose films. W. Berry, C. R. Oswin. To: British Cellophane Ltd.

B.P. 700,623. Production of moisture-proof regenerated cellulose films. G. D. Bond, B. Samways. To: British Cellophane Ltd.

B.P. 700,698. Device for dispensing razor blades. J. B. M. Palmer. To: Pal Persona Blades Ltd.

Special shape of slot by cutting away one of the end walls adjacent the bottom of the plastic container with blade-positioning abutments, guide rails, pusher and spring.

B.P. 700,727. Sealed joints between moulded plastic members and solid elements embedded therein and method of sealing said joints, for example as applied to ignition coils. To: International Harvester Co. (U.S.A.).

Closure members are injection moulded from thermosetting phenolic material into the metal casing arranged in the mould with a rubber seal adhering to the metal. The heat of the plastic vulcanizes the rubber forming the gasket.

B.P. 700,737. Electric rotary switches. To: Busch-Jaeger Lüdenscheider Metallwerke A.G. (Germany).

A vulcanized fibre ring resistant to sparking is pressed into the injection-moulded synthetic-resin switch base.

B.P. 700,745. Synthetic resinous products. L. N. Phillips. To: National Research Development Corp.

Concerns materials from furane derivatives.

B.P. 700,746. Covered rollers. C. M. Turton. To: J. R. Thompson and Co. (Otley), Ltd.

Inking rollers are provided with a layer of a resilient composition of low melting point under an outer covering of plasticized polyvinyl chloride. The composition may be gelatine-glycerine-water or a thermoplastic of similar characteristics.

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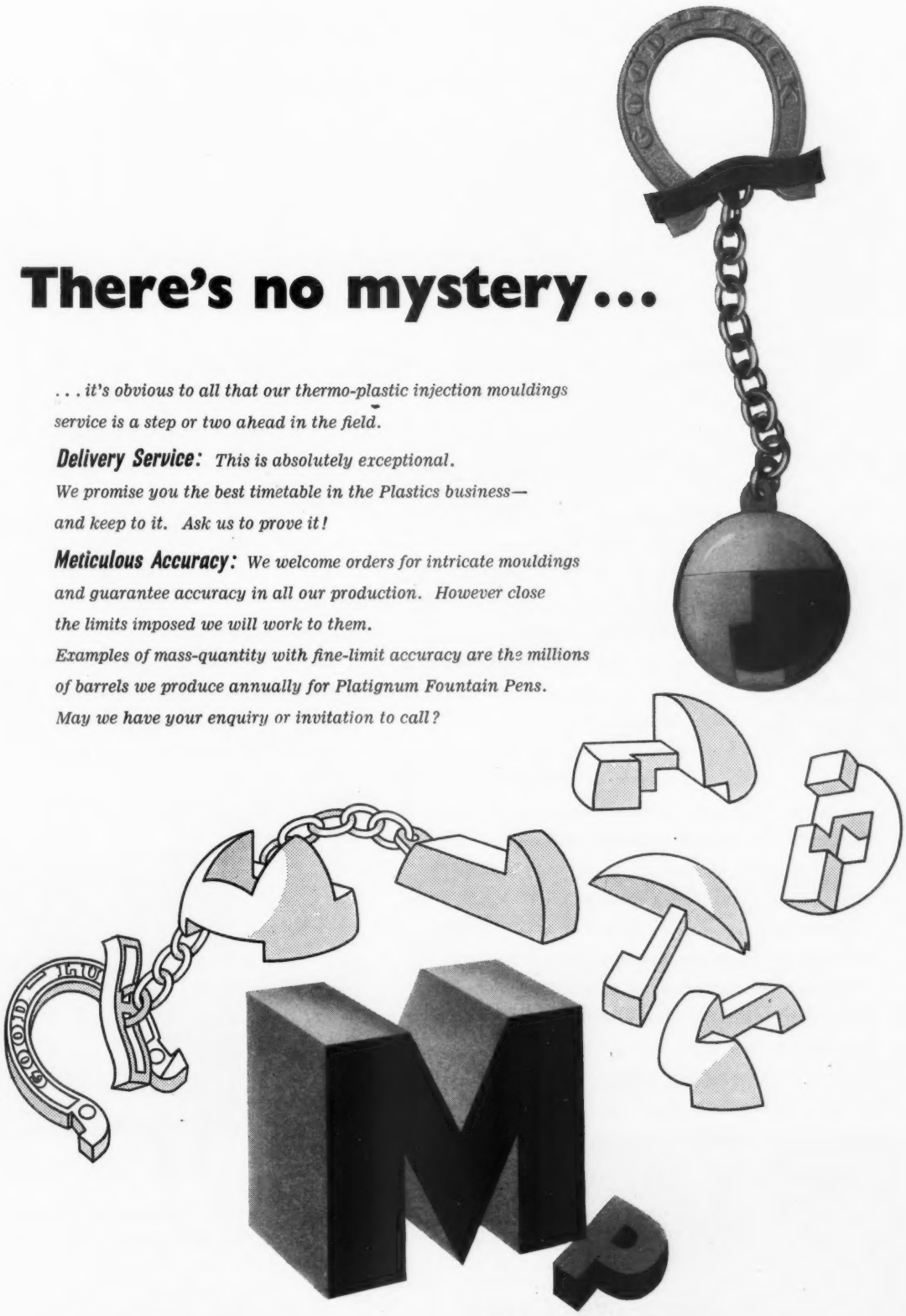

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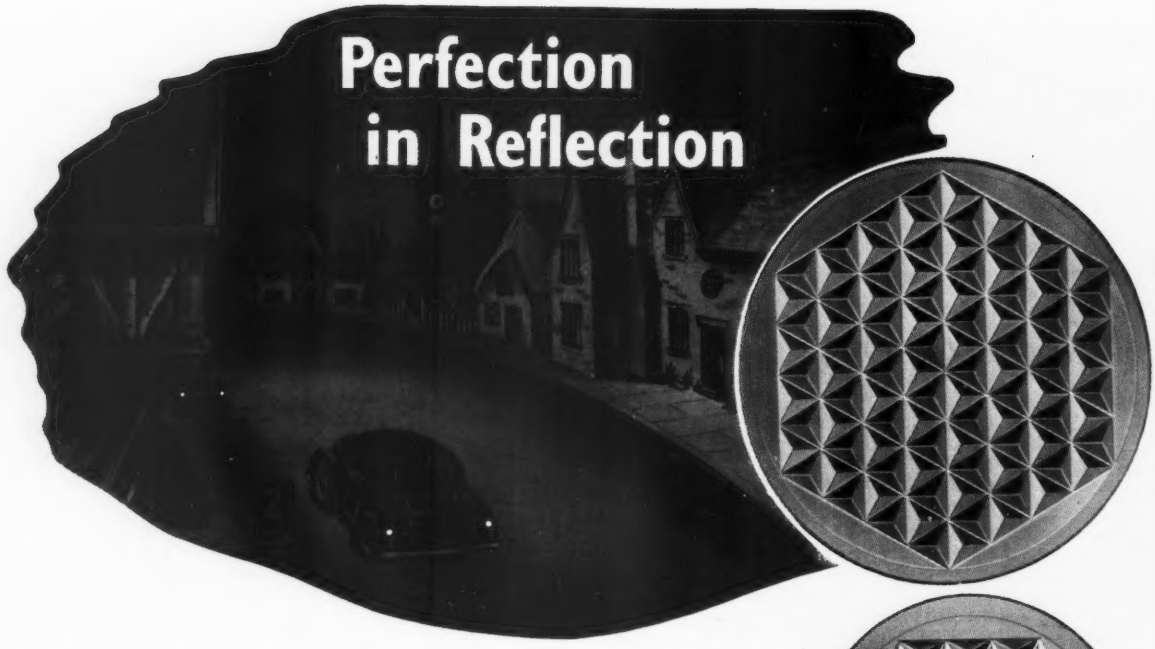
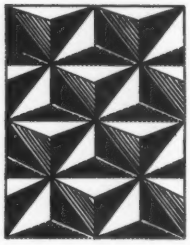
G&G

Perfection in Reflection





The tremendous expansion in traffic pouring on to already overcrowded highways has resulted in the introduction of new legislation in an effort to reduce the increasing toll of the roads.

One of the most promising innovations is the more widespread use of reflectors. To produce them in the quantity required and at short notice has tested the ingenuity of the plastic moulder.

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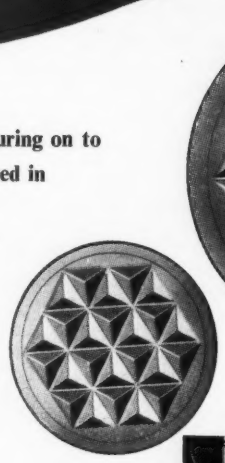

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P2968

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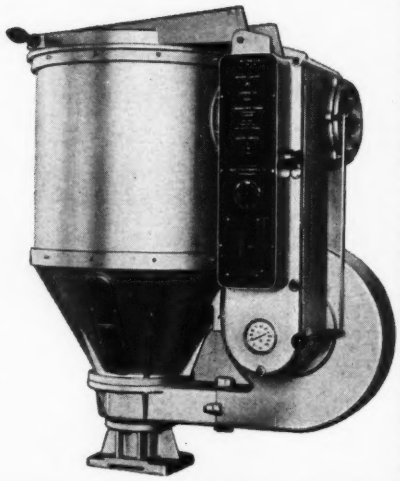
Pre-dryer and Pre-heater

for DIRECT MOUNTING on INJECTION-MOULDING MACHINES and for use with every type of injection-moulding material.



The **Continator** is a complete unit, of small dimensions. mounted in replacement of the normal Hopper. It eliminates drying cabinets and trays, thus saving time and labour, and economises on material by direct feed from the original container. It is made in lightweight metal, has no painted parts, and is fitted with a powerful magnetic separator.

The **Continator** is available in two standard sizes :—
No. 100/5, suitable for all machines of up to 4-oz. capacity.
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It is supplied complete with electric motor wound to suit any electricity supply.

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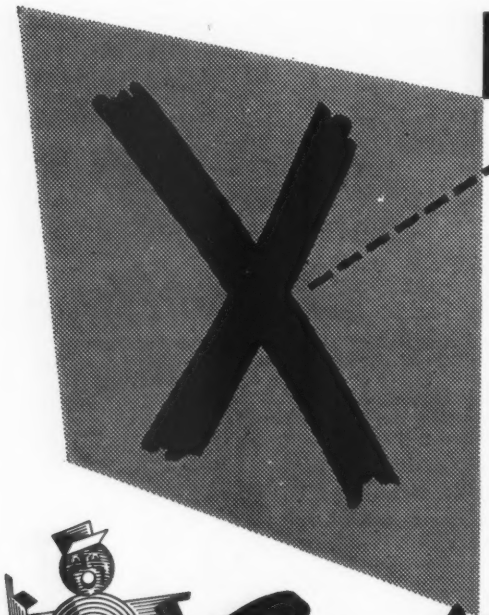

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Now you can buy a pre-determined-length dispenser which gives you accurate cuts all the time. Quixet dispenses strips in any width up to 3" and in lengths from 1" through ¼" stages to 10". Quixet provides generous "tape grip" for fast cutting—saves time, makes taping so much easier, eliminates waste! Full information with pleasure on request.

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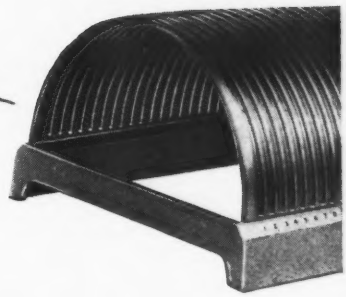
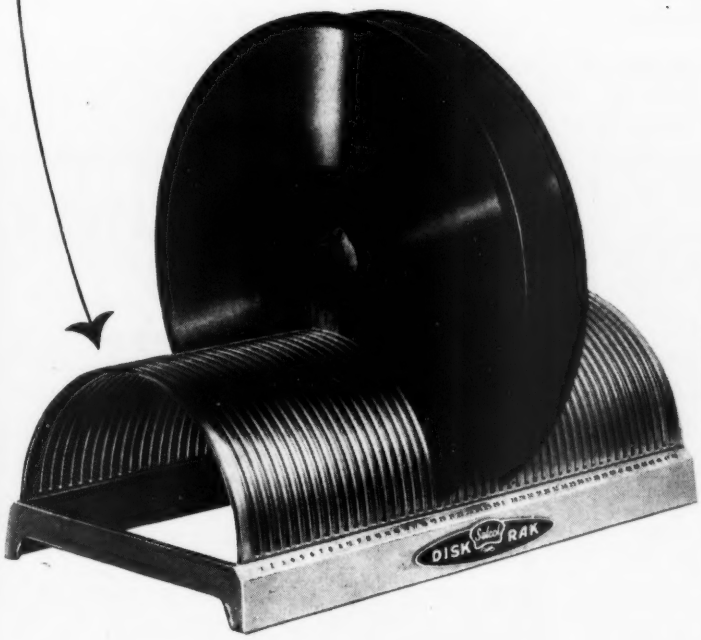


The tool for this polystyrene gramophone record rack incorporates 49 pin-point gates and automatic degating. The moulding is ejected from the machine in the finished state, degating being performed automatically as the mould is opened. This makes possible a production rate of 60 shots per hour.

The moulding is by Thames Valley Moulders, on an 8 ounce Peco machine—for Selcol Products.



THE MOULD IS BY "UNIVERSAL" OF COURSE

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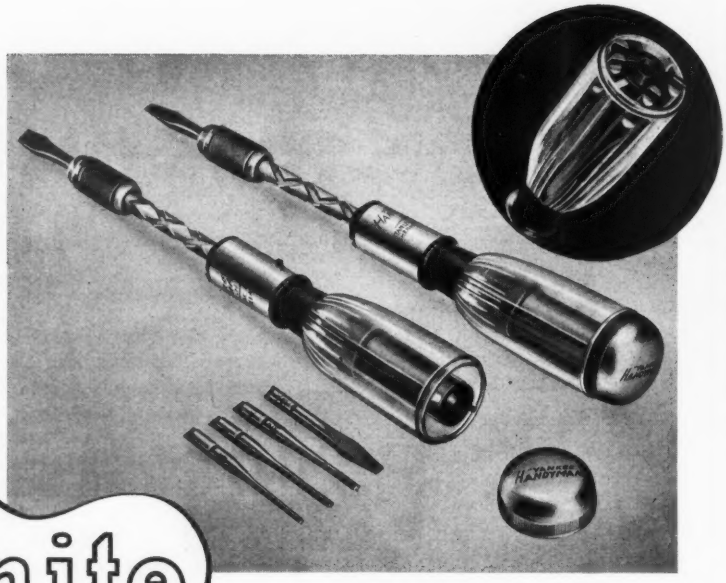

* *They're tough — and will stand any amount of knocking about in the workshop or the tool bag.*

* *They're transparent — you can easily see interchangeable bits in the hollow handle without removing the cap.*

* *They're dirt-resisting — oil and grease don't affect them.*

* *They're moulded from* **Tenite BUTYRATE**

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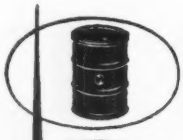

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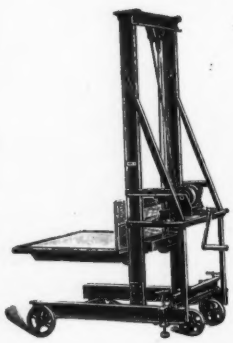

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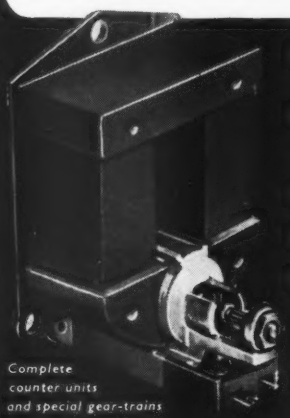

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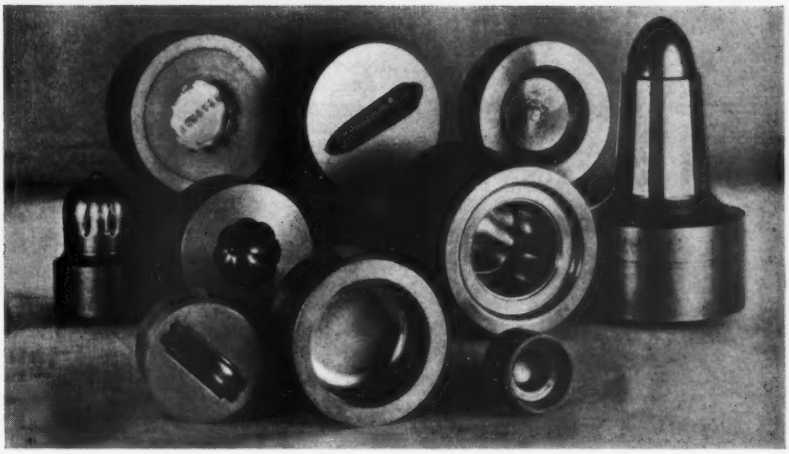

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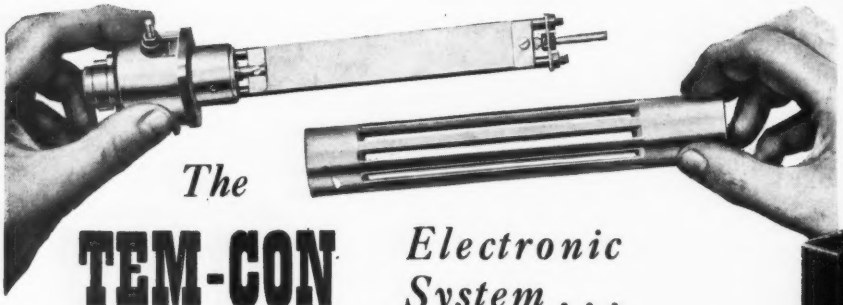

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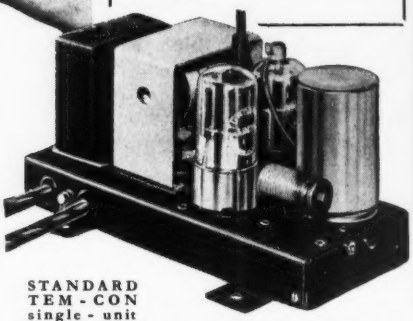

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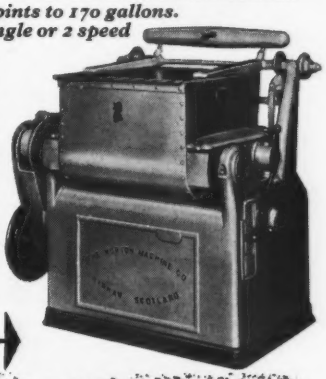

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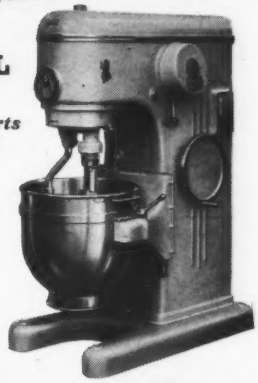

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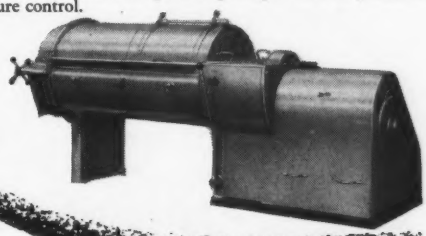

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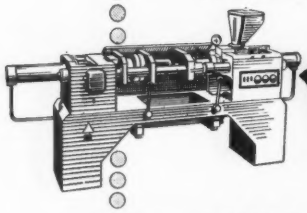

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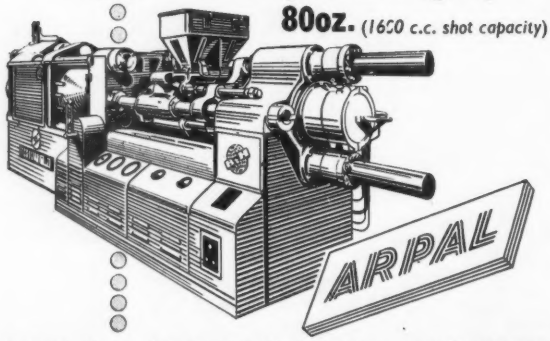

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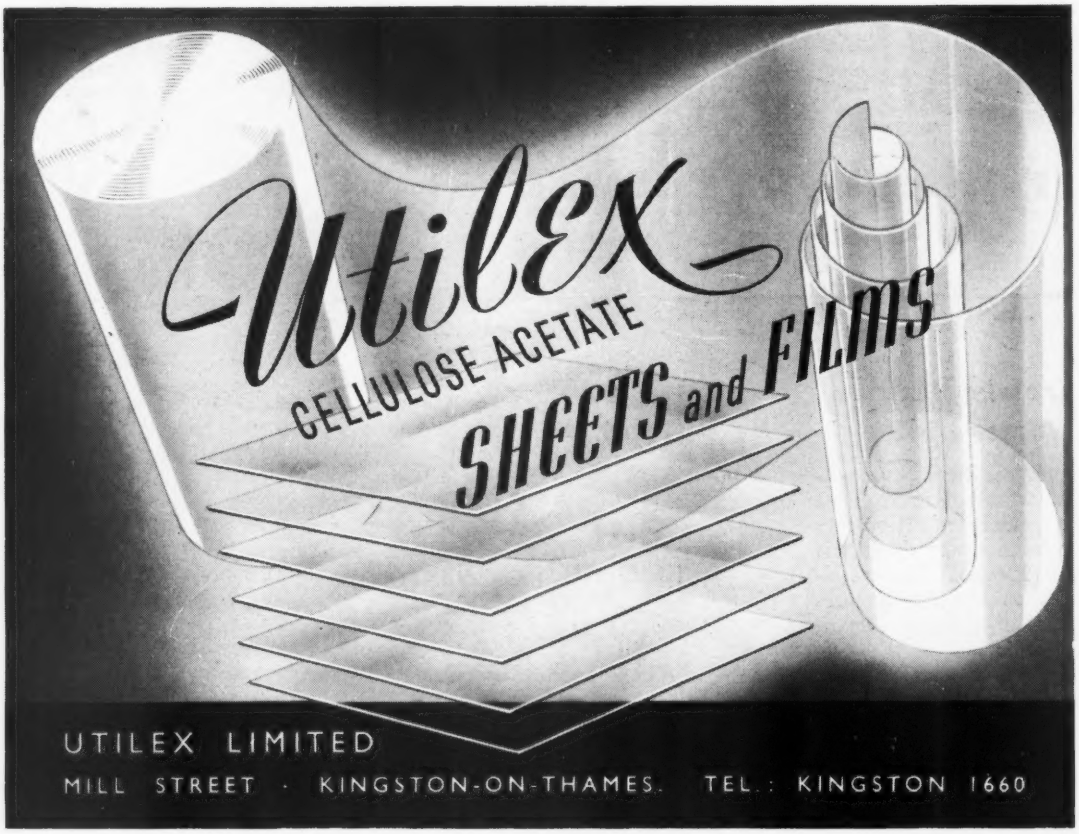

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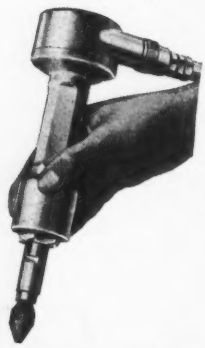

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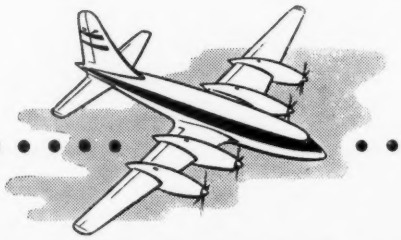

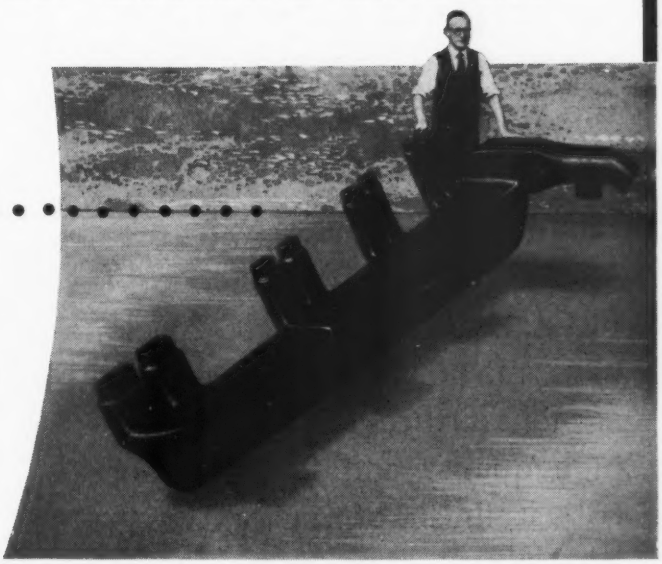

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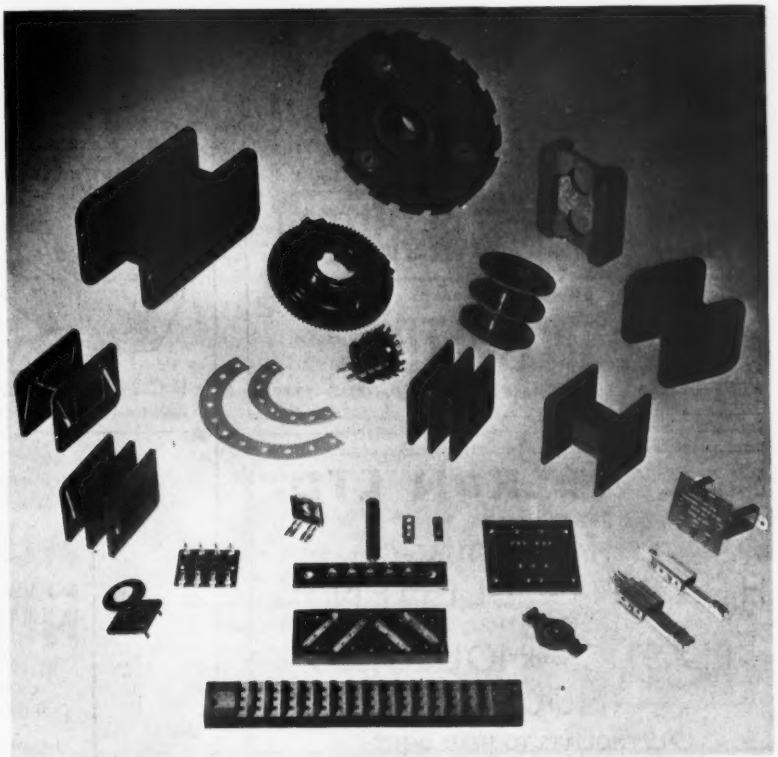

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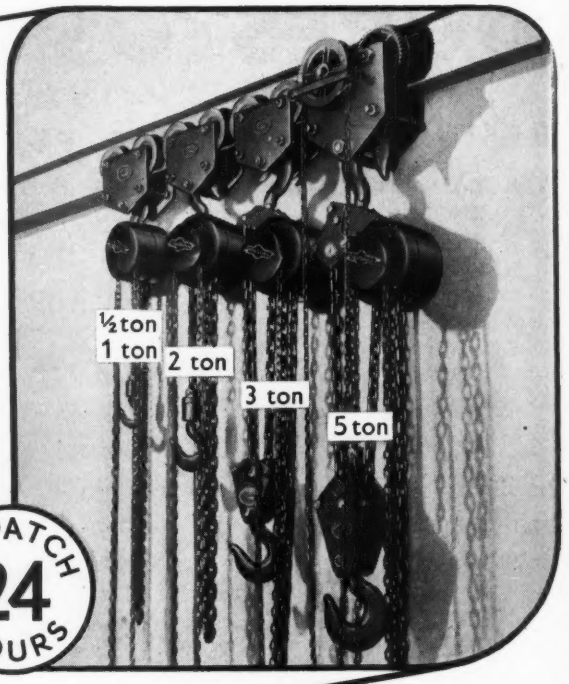

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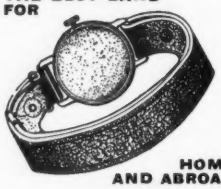

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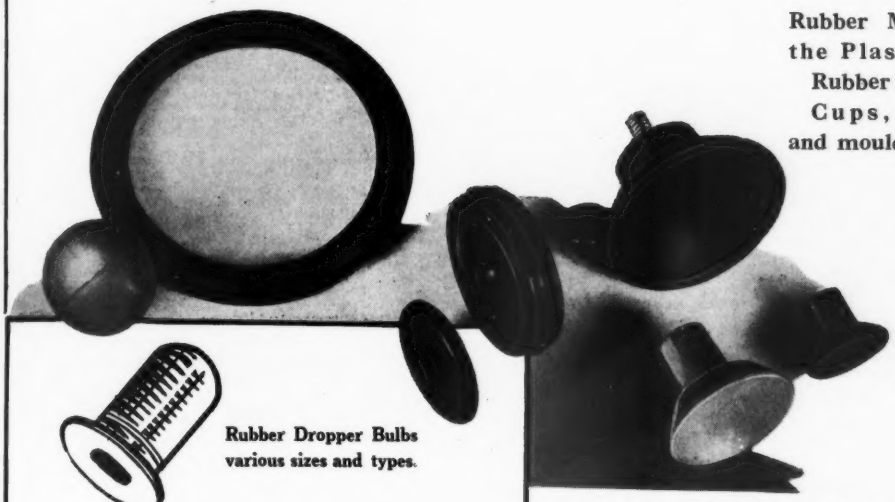

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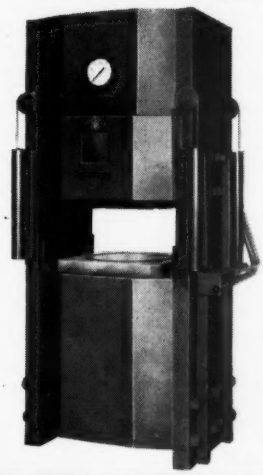

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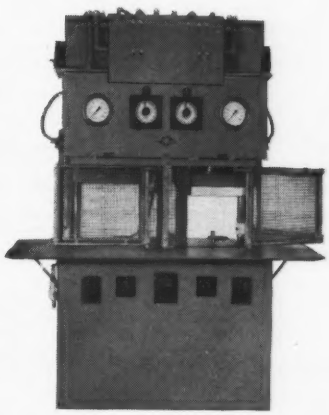

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150-ton downstroke by Francis Shaw, main ram 14-in. dia. by 26-in. stroke, four columns, distances between 28 in. by 12 in., table 28 in. by 26½ in., daylight 28 in., fitted transfer moulding or ejector ram, 4½-in. dia. by 12-in. stroke, automatic prefilling, W.P. 1 ton sq. in.

100-ton downstroke by T. H. and J. Daniels, main ram 12-in. dia. by 16-in. stroke, four columns, distances between 20½ in. by 10¾ in., tee-slotted, fixed and moving tables each fitted 20 in. sq. electric platen, daylight between platens 20 in., fully guided table returned by two 3-in. dia. pushback rams, with hydraulic hanger-bar ejector, prefill valve and pumping equipment by Towler, motorized 1½ h.p. 400-440-3-50.

75-ton upstroke by T. H. and J. Daniels, main ram 8-in. dia. by 14-in. stroke, four columns, distances between 14 in. by 9½ in., table 17½ in. by 14 in. returned by two 2½-in. dia. push-back rams, daylight 24 in., W.P. 1½ tons sq. in., self-contained pump by Towler, motorized 400-440-3-50.

40-ton upstroke by Hollings and Guest, ram 6-in. dia. by 12-in. stroke, four columns, distances between 15½ in. by 5½ in., fully guided table 12 in. by 12 in., daylight 1 ft. 9½ in., W.P. 1½ tons sq. in.

25-ton upstroke by Plastics and Rubber Mchy. Co., ram 4-in. dia. by 10-in. stroke, four columns, distances between 11¼ in. by 6¼ in., fully guided table 12 in. by 11¼ in., daylight 20 in., W.P. 2 tons sq. in.

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Write fully, salary required, etc., to Prestware, Lombard Rd., London, S.W.19. 200-38

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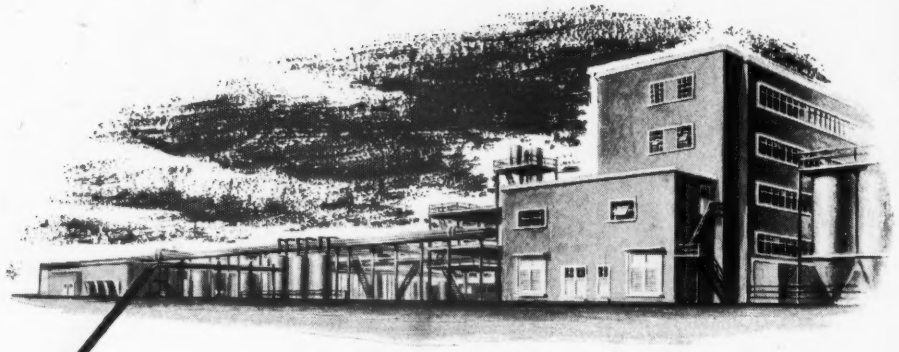

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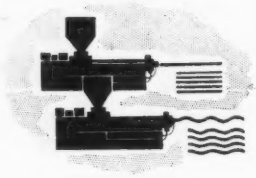

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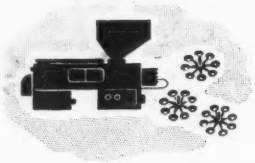

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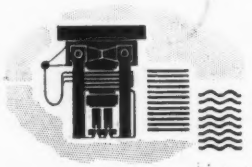

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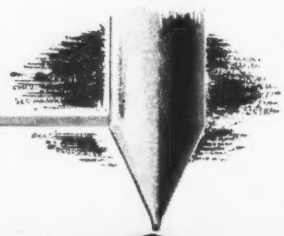

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